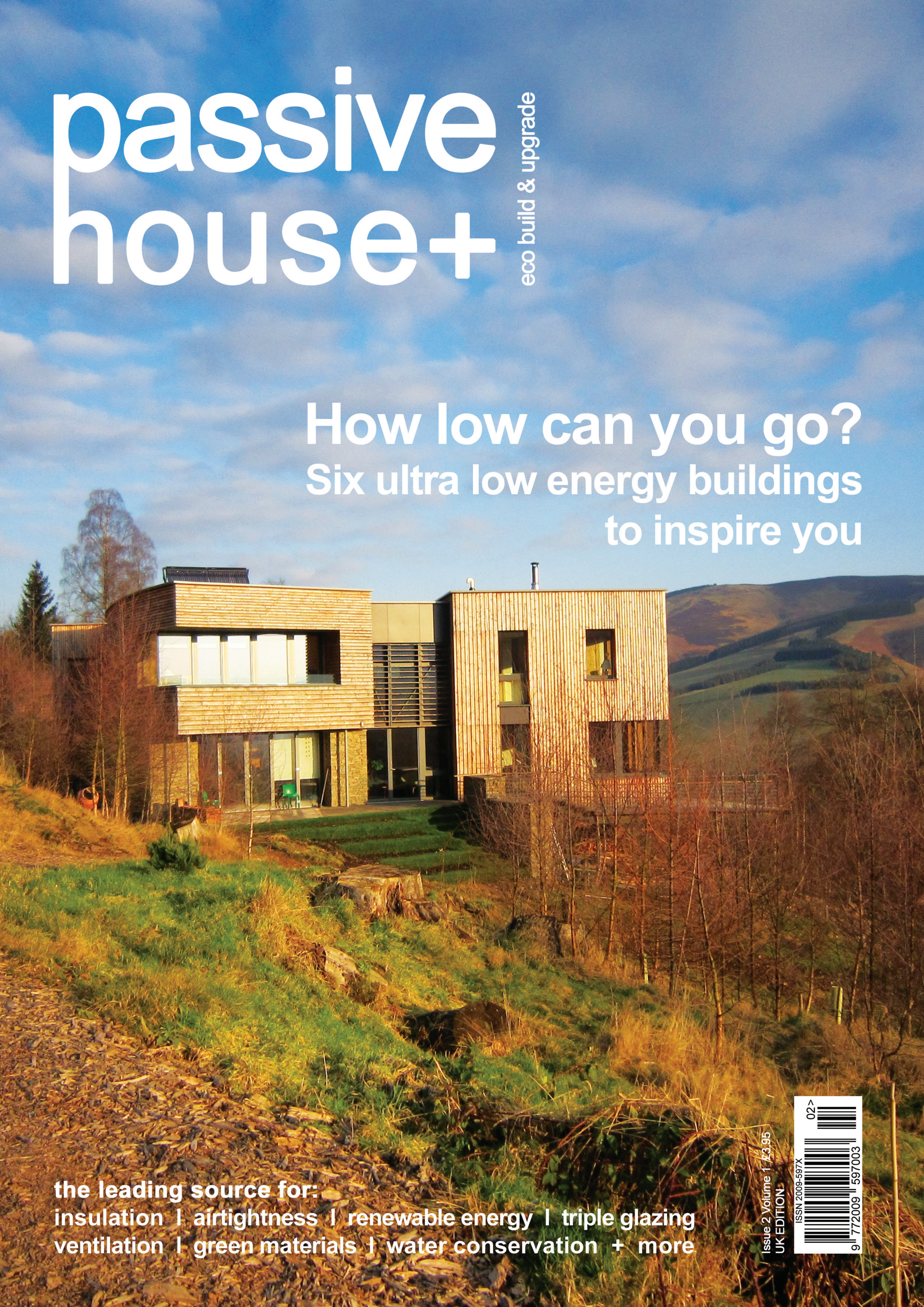

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Issue 2 Volume 1 £3.95
UK EDITION
ISSN 2009-597X

editor's letter

Welcome to the first UK edition of Passive House Plus, the world's first English language magazine focused on the passive house approach to building and upgrading.

Make no bones about it: passive house is the world's leading low energy building standard, bar none. As such it's one of the key tools mankind possesses in the fight against climate change, energy and resource depletion, and threats to public health.

The reason is simple: It decides what the priorities should be based on logic, supported by a growing weight of evidence.

In contrast, much of the rhetoric surrounding sustainability evades such clear definition, or lacks sufficient detail to possess value. How do we define what is green? Even a term like zero carbon – though its numeral hints towards a clear target – is of little value. An intolerably cold uninsulated shack on Ben Nevis could achieve a zero carbon rating, if attached to a sufficiently large wind turbine or solar photovoltaic array. Such an example is undeniably absurd, but the point is very real: a sustainable building target will only be successful if the buildings that result are successful. People have to feel the benefits – and not just in some abstract and virtuous environmental sense – but in terms of tangible returns such as improved comfort and health, reduced running costs and an asset that will appreciate in value for decades to come.

And simply accepting that high levels of insulation are necessary isn't enough. Insulation, thermal bridging, airtightness and ventilation must all be considered together – as indeed should building size, form, layout and orientation, and many other aspects. If we aim to make dramatic improvements to some aspects of a given building's energy performance, but do so without the sort of rigorous, joined-up thinking that characterises passive house, we risk creating a sick building, and causing people to become wary of energy efficiency interventions per se.

In these pages you'll find thoroughly researched, detailed information on buildings designed to – or in some cases close to – the passive house standard. We'll always aim to make it clear which is which. We'll endeavour to cater for readers with varying levels of knowledge of the minutiae of sustainable building. That's why, for instance, we siphon off most of the technical detail of profiled buildings into standardised panels at the end of each article. That's why we'll have a glossary in every issue, with more terminology explained each time.

Though Passive House Plus is a new title, the team behind it are no novices. In 2003 my colleagues and I set up Construct Ireland (for a sustainable future), a magazine that worked hard to advance the understanding and uptake of sustainable building in Ireland. We had some real successes, perhaps most notably in our role in the development of 60% energy and carbon reduction targets for new homes, along with mandatory on-site renewable energy systems, under changes to national building regulations. We won awards for our work, and became demonstrably the leading construction magazine in Ireland. It speaks volumes for how far sustainable building has come in Ireland – and in an industry infamous for its inertia – that its leading building magazine could become not only a sustainable building magazine, but a magazine focused on the pinnacle of energy efficiency.

My colleagues and I would like to sincerely thank the individuals and companies who have made this magazine possible, including our advertisers, contributors, and the readers who act based on the information we provide, and build better as a result.

Regards,
the editor

IMA

2012 Business magazine of the year - Irish Magazine Awards

GREEN AWARDS 2010 WINNER Green Leader Award

GREEN AWARDS 2010 WINNER Green Communications Award

Jeff Colley:
winner - green leader award - Green Awards 2010

Construct Ireland:
winner - green communications award - Green Awards 2010

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éASCA ENVIRONMENTAL & SUSTAINABLE CONSTRUCTION ASSOCIATION PASSIVE HOUSE

Passive House Plus (Irish edition) is the official magazine of Éasca and the Passive House Association of Ireland

I2 V1

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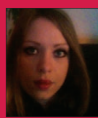

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PRINTING: GPS Colour Graphics,
T: 028 9070 2020
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Publisher's circulation statement: Passive House Plus (UK edition) has a print run of 11,000 copies. 10,000 copies are posted to architects, clients, contractors & engineers. This includes the members of the Passivhaus Trust, the AECB & the Green Register of Construction Professionals, as well as thousands of key specifiers involved in current & forthcoming sustainable building projects

Cover: Plummerswood
Photograph: Sandy Halliday

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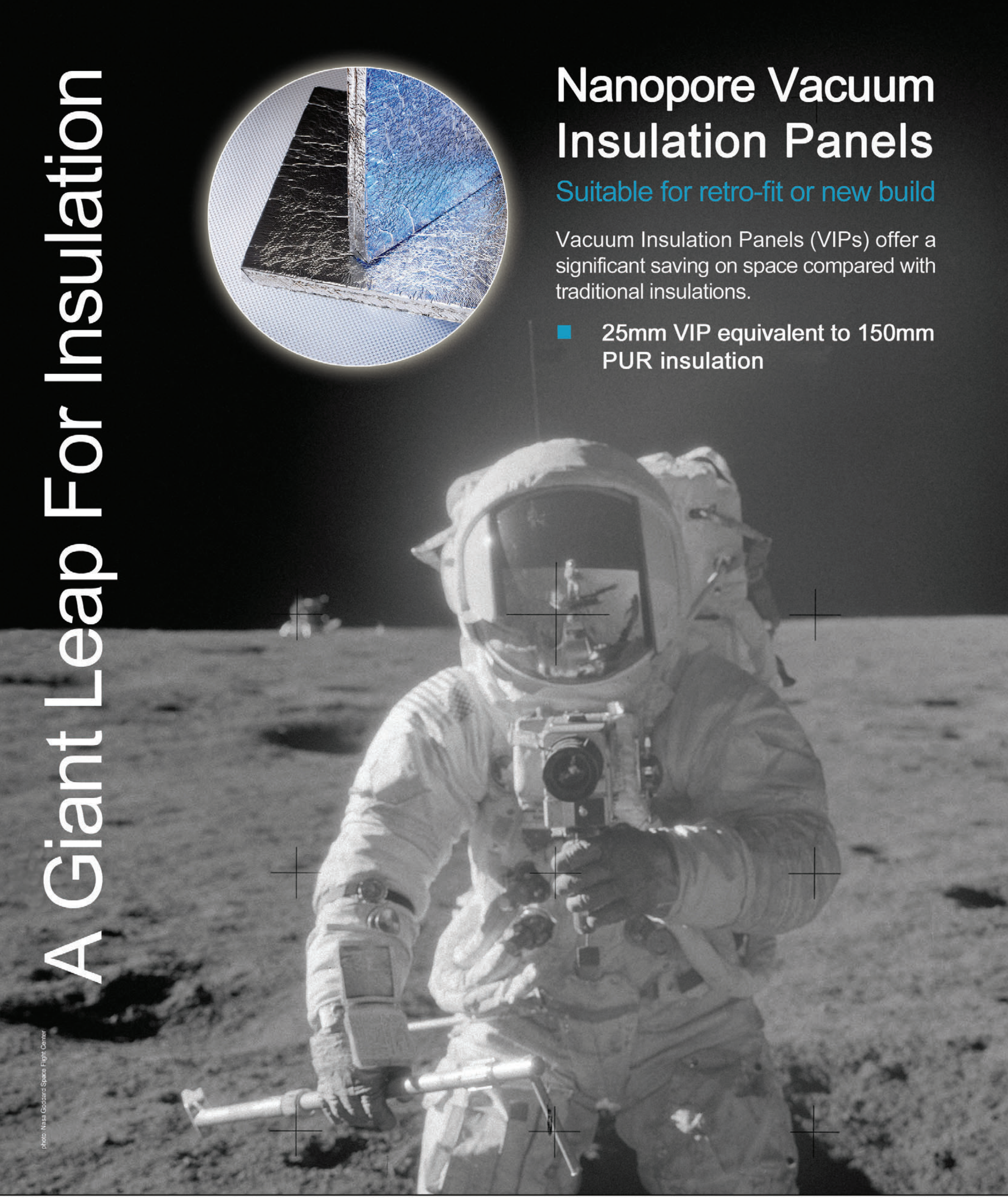

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contents

News

Passive House Plus wins business magazine of the year award

Photo: Paul Sherwood/Irish Magazine Awards 2012

We're delighted to announce that Passive House Plus has won the business magazine of the year award at the 2012 Irish Magazine Awards.

The judges of the awards – which were announced at a swanky event at Dublin's Clyde Court Hotel in December – cited the magazine's "high editorial and design standards" and "commitment to audience engagement".

Passive House Plus pipped some stiff competition to win the gong. Finalists vying for the large circulation Business to Business Magazine of the Year award (for publications with circulation above 5000 copies) included Business Plus, Euro Times, the Law Society Gazette and the Engineers Journal.

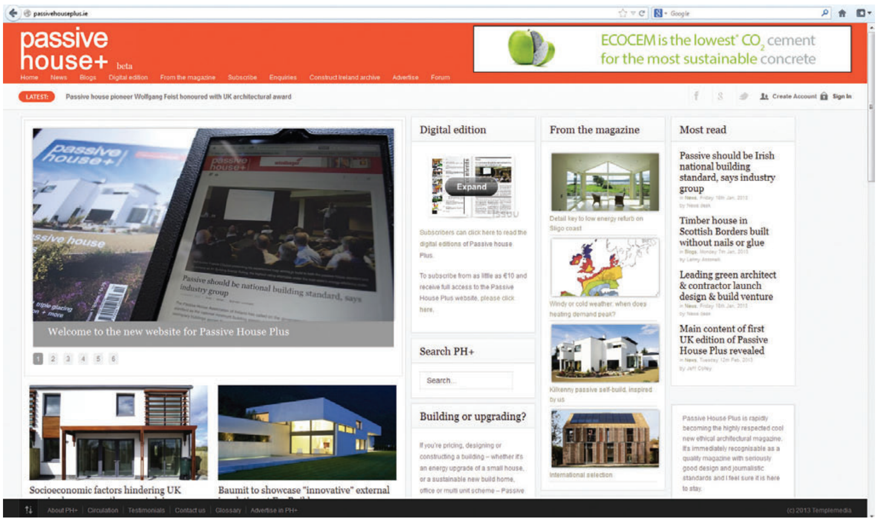
"This kind of recognition means a great deal to us – It's an amazing endorsement of our decision to rebrand from Construct Ireland to Passive House Plus and expand into the UK," said Passive House Plus editor Jeff Colley. "A massive thanks to all our subscribers, advertisers and contributors. Without your loyalty, we'd be nothing."

The magazine's rebrand and expansion project also saw Passive House Plus nominated under the innovation of the year category, with Colley nominated for business magazine editor of the year.

(above) Pictured at the Irish Magazine Awards are Passive House Plus editor Jeff Colley and Magazines Ireland chief executive Grace Aungier

Passivehouseplus.ie website launched

Passive House Plus magazine has launched its new website, passivehouseplus.ie. The website is still in beta version and is best viewed on laptops and PCs, with optimisation for tablets and smartphones to follow imminently.



News, blogs, events and a lively forum will be available on the site absolutely free, along with ten years worth of archived articles from the award winning Irish green building magazine which preceded Passive House Plus, Construct Ireland. Users can register on the site for free to comment on articles, post in our forum, and add events to our online calendar – all subject to approval and moderation of course.

Content from the print edition of Passive House Plus will also be posted on the website. Subscribers to the UK or Irish editions of the print magazine will get access to all content behind the paywall at no extra cost, while readers who want to go paper-free can subscribe to the digital edition for just £8 (or €10) per year. All subscribers will be granted access to all past digital editions of the magazine.

Passive House Plus published its first, Ireland-only edition, in late 2012. This second edition of the magazine has been published in both UK and Ireland versions, as will be the case with all future editions.

If you'd like to try out the magazine before you subscribe, you can access the digital version of the first issue for free if you fill out our enquiry form at passivehouseplus.ie, or on page 16 of this issue.

If you're looking to build or upgrade, and you want to go to passive house levels or address other aspects of sustainability, then fill out the form, tell us about your project and the kinds of products and services you'd like to consider using, and we'll pass your enquiry on to the advertisers from our magazine equipped to help you.

Whatever you do, we hope you'll get involved. Use our comment threads and enquiry form, email us a letter to the editor, submit ideas for news or blogs, tell us what you think about the magazine and the site, and contribute to the ongoing discourse on sustainable building.

News

International conference to visit nine passive buildings

No other city has more passive house buildings than Frankfurt, and participants at the 2013 International Passive House Conference will be able to visit selected examples including homes, homes, schools and even a fire station.

A total of nine guided tours will be offered on Sunday 21 April, with building owners and occupants at hand to talk about their projects.

One of the tours will include a school in the Frankfurt Nordend district. In order to preserve the historical appearance of the school building, it was decided that the new school canteen should be located underground. "Our very first underground passive house, which is simply out of this world," said Mathias Linder of the City of Frankfurt building department.

In Praunheim, participants will visit the Liebigschule Passive House school sports hall which has been built as a flexible modular system. "This is a building block system which adapts to its surroundings," said Linder. There will also be a visit to the refurbished Carlo-Mierendorff School in Preungesheim.

Another excursion will take visitors to the Bahnstadt district in the city of Heidelberg, located one hundred kilometres south of Frankfurt. An entire urban district has emerged on this former rail freight terminal, with different types of buildings built to the passive house standard. A lively mix of residential, scientific, commercial and cultural buildings on 116 hectares of land makes this project a model for sustainable urban development.

The excursions will start in the morning on 21 April 2013 from the Frankfurter Congress Centre, the venue of the International Passive House Conference 2013. The price of €95 for each excursion includes the cost of transfers and catering as well as tour guides with English translations. Tours will end in the afternoon at Frankfurt's central railway station. The number of participants is limited, therefore early booking is advised.

The 2013 International Passive House Comfort takes places in Frankfurt from 17 to 21 April.

For more information see www.passivehouseconference.org

Record number of products get passive house certification

The Passive House Institute has announced that it certified 134 products last year, a new record. These components included everything from sliding doors and dome lights to balcony systems.

The institute presented certificates for a range of new products at the BAU 2013 trade fair in Munich in January.

"Anyone building a passive house today has a wide range of high quality products to choose from," said Professor Wolfgang Feist, director of the institute. He said that in the past few years, pioneers in the market have improved their products and simplified their application, and new suppliers have entered the market too.

"As a result, a great variety of building components required for passive house are now available and, in many cases, these components have become cheaper."

At the end of 2012, passive house designers could choose from over 100 certified ventilation units and nearly 100 window frames.

As an independent authority, the Passive House Institute tests and certifies products with regard to their suitability for use in passive house buildings. The institute said that its certification guarantees "the highest standard of thermal comfort when used in any energy efficient building".

At the BAU trade fair in Munich, certificates were presented to companies including Schöck Bauteile for thermal insulation, Schüco for their curtain wall facade, Raico Bautechnik for their aluminium window frame and Schiedel for their extract air system.

(above) Prof Wolfgang Feist has announced that the Passive House Institute certified 134 products in 2012

Must read - The Passivhaus Handbook

The Passivhaus Handbook – A Practical Guide to Constructing and Refurbishing Buildings for Ultra-Low-Energy Performance is an essential guide for anyone interested in the passive house approach to building or upgrading.

Written by UK passive house pioneers Janet Cotterell and Adam Dadeby, the Passivhaus Handbook will be of benefit to anyone looking to build an extension, upgrading or starting from scratch. Bringing together current thinking and best practice on passive house, this book will help you navigate around the potential pitfalls and misconceptions, and will be a key reference for everyone from green minded homeowners to experienced passive house designers.

The book can be purchased via www.greenbooks.co.uk/passivhaus

News

X-Floc brings range of blown insulation machines to the UK

German manufacturer of blown insulation machines X-Floc GmbH have appointed X-Floc UK Ltd as the sole distributor for UK and Ireland.

X-Floc GmbH specialises in the research, development and manufacture of blown insulation machines and accessories.

The range includes mobile, onsite and factory-fill machines with systems for installing all blown insulation material. The company said such systems are "an essential tool in the passive house sector of the housing market where quality of installation is essential".

"We are delighted to work with X-Floc UK Ltd to introduce our range of machines to the UK and Ireland," said X-Floc GmbH founder and managing director Axel Greiner. "We started manufacturing in 1995 and since then have delivered to more than 25 countries."

"We believe good machines should be complemented with a complete set of accessories. Blown fibre insulation material needs to be installed into many diverse designs and conditions and so we offer a full range of injection nozzles and lances and a comprehensive spraying system for all applications," he said.

At BAU 2013, the popular architecture and building materials trade show, X-Floc launched the EM300, a high powered insulation blowing machine with "innovative material conditioning technology".

Jasper Meade, director of X-Floc UK said: "Blown fibre insulation arrives at site in compressed bags for easy delivery. The EM300 ensures that the material properties of any blown insulation are installed at the highest possible speeds, maintaining accurate densities and quality."

(right) The X-Floc EM300 insulation blowing machine

Demand control hits heat recovery ventilation market

Ventilation specialists Aereco have launched DXR, a fully demand controlled mechanical ventilation system with heat recovery (MVHR). The company said that it believes DXR is the first ever fully demand controlled domestic MVHR system both on supply and exhaust.

Aereco said its new DXR system can achieve 92% energy savings compared with a mechanical exhaust ventilation (MEV) system at constant airflow, while providing the same indoor air quality.

The company said that DXR is engineered to automatically adjust ventilation according to the specific needs of each room, as opposed to other products in the market that have constant or globally controlled airflows.

DXR "combines the benefits of both airflow modulation and heat recovery," said Aereco Ventilation Ltd sales director Colin Hone. "Modulation enables a significant reduction of the average airflows while providing excellent air quality. Heat losses on average are halved in comparison with a constant airflow ventilation system. The heat exchanger operates with a yield of around 85% recovery thereby achieving in the region of 92% energy savings compared with an MEV system."

Additionally, Hone said that DXR has low primary energy consumption through the use of efficient fans, low pressure operation and reduced airflow.

"By reducing the average airflow by about 50%, DXR reduces filter clogging, and doubles filter durability in comparison with traditional heat recovery systems, thereby reducing pressure drops, and power consumption of the motors," he added.

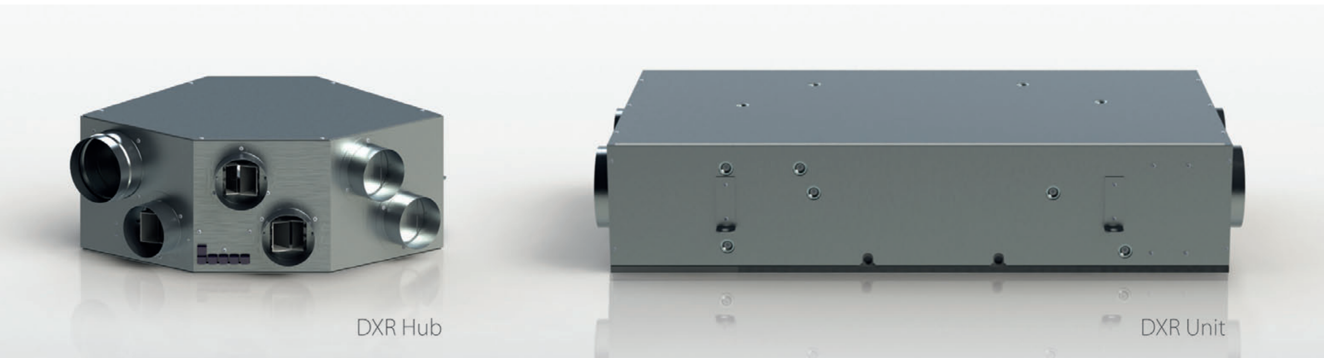
The Aereco DXR system is composed of a DXR heat recovery unit connected to exhaust units and to the DXR Hub dispatching box, which controls the supplied airflows.

Each supply unit is directly connected to the DXR Hub, which in turn adapts the supply airflow in all main rooms based on the CO_2 rate (or presence), proportionally to the measured level of pollutant. At the exhaust point, the company's tried and tested BXC units automatically adapt airflow to variable settings depending on humidity in bathroom, presence in WCs; humidity and switch in the kitchen for the boost airflow. Carbon dioxide or VOC detection versions can also be used for exhaust units.

Supply and exhaust airflows are balanced by constant monitoring via two automatically controlled compensation valves that can be located in the living room, in the kitchen or in a corridor. The by-pass located in the heat recovery unit automatically shunts the exchanger when the outside temperature is mild enough and can also be used in free-cooling mode to provide night cooling in summer.

Aereco will be exhibiting at Ecobuild at stand N2615.

(below) Aereco's innovative DXR demand controlled MVHR system



News

Baumit to showcase "innovative" external insulation render at Ecobuild

Baumit UK will be showcasing an "innovative" new external thermal insulation technology on 5-7 March at Ecobuild 2013 in Excel, London.

The Baumit Open external wall insulation (EWI) system is a thin coat render system for solid wall construction.

Baumit said the system provides breathable thermal insulation, plus energy and cost savings, and comes in a broad range of render colours and finishes. It also has self-cleaning properties that increase the life span of the external finish, reducing costs in re-painting, the company said.

Baumit are now offering their portfolio of external thermal insulation systems, façades and renders to the UK market through their network of distributors and highly trained installers.

“Feedback from renovations and new builds where the revolutionary Baumit EWI system has been used has been very positive, with many homeowners reporting considerable energy and cost savings as well as a high level of improvement to the external façade appearance,” said Sue Dewhirst, consultant with Baumit UK.

The company said its "broad portfolio of EWI and rendering products provides a one-stop-shop for architects, builders, designers, and specifiers aiming for improved energy and cost efficiencies, insulation properties and compliance with Green Deal requirements."

Its portfolio of products also includes: Baumit Star Track (an insulation anchor fixing system that eliminates thermal bridging and is applicable to any existing surface); Baumit Life (a colour system featuring 888 façade colours); Baumit Profiles (a comprehensive range of façade profiles for window, doors, corners and other applications); Baumit NanoporTop (a low maintenance decorative finish based on nanotechnology that provides a "breathable self-cleaning top coat for long lasting cleanliness and beauty for the façade"); and Baumit Open Duplex, a remediation product for existing thermal insulation systems.

Baumit said that throughout the temperature and humidity changes that external walls experience, the Baumit Open EWI system delivers stability, heat retention, fire protection and sound insulation within the home.

Visit Baumit at Ecobuild at stand N1050.

(above) A low energy modernist house externally insulated with the Baumit system

Passive house founder to get RIBA fellowship

Passive house founder Professor Wolfgang Feist will receive a fellowship from the Royal Institute of British Architects in London on 6 February.

During his trip to the UK he will also be visiting exemplar passive house sites in London and Norwich, organised by the Passivhaus Trust, and giving a talk on 5 February in the University of East Anglia.

"I feel extremely honoured to have been selected for such a prestigious award from such a highly regarded organisation as the Royal Institute of British Architects," Prof Feist said. "The extent to which the passive house standard supports good architecture has been demonstrated by RIBA’s recognition of my work in the field. High levels of energy efficiency and excellent architectural design go hand in hand, with all building shapes and styles possible."

He added: "This award also confirms that passive house has become established in the UK with many passive house buildings already built throughout the country."

Green solutions the focus of German building services fair

ISH 2013, the "world's leading trade fair" for bathrooms, building services, energy, air conditioning technology and renewable energies, will take place in Frankfurt from 12 to 16 March. The event is organised by Messe Frankfurt and will be hosted at the Frankfurt Fair and Exhibition Centre.

The ISH energy section will focus on efficient heating systems and renewable energies, as well as achieving energy efficiency and comfort with ventilation and air conditioning technology.

The water section will "spotlight the way water is used and set new accents with regard to drinking-water treatment and sustainability".

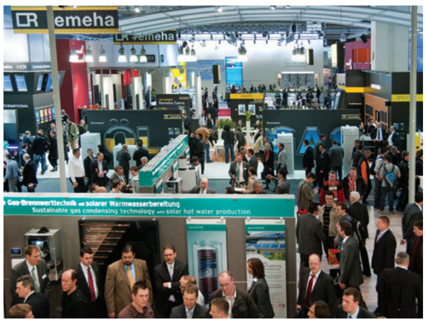
Over 2,300 exhibitors and 200,000 visitors are expected to attend the event.

The sanitation, heating and air conditioning installation trade will make up the largest group of visitors.

Visitors will also have the opportunity to take part in over 30 workshops and lectures revolving around the subject of "holistic bathroom planning".

Air conditioning, cooling and ventilation technology will feature in the Aircontec section of the exhibit. The industry will present "innovative components and systems that, besides a high degree of energy efficiency, ensure thermal comfort and high-quality indoor air".

“Resource conservation is the subject around which everything at ISH 2013 revolves – without neglecting comfort and design”, said Iris Jeglitza-Moshage, senior vice president of Messe Frankfurt Exhibition.



(above) Visitors and sustainable energy exhibitors mix at ISH 2012

News

Work starts on innovative Yorkshire barn retrofit

Work is underway on the pioneering low energy retrofit of a derelict farm building at the Yorkshire Wildlife Trust's Stirley Community Farm in Huddersfield. The design and build project, led by passive house firm the Green Building Store, will turn the barn into an "all-purpose, flexible educational centre and space".

A super-insulated timber frame structure will be built into the existing stone building, preserving the outward appearance of the barn. The project will aim to meet Enerphit, the Passive House Institute's standard for retrofit.

In addition to the usual passive house considerations of super insulation and airtightness, minimisation of thermal bridging and use of mechanical ventilation with heat recovery, the project will be tackling issues such as structural stability of the original barn structure, and prevention of water penetration from the stone walls and rising damp.

In order to support and shore up the stone walls, the inner frame will brace the original barn fabric through a purpose-designed tie system, developed by the Green Building Store team and structural engineers. To minimise thermal bridging with this system, the tie connection to the inner timber structure has been "carefully detailed" to ensure it is fully insulated.

"The design of the Enerphit Cre8 barn will ensure that its heating requirements are tiny — a public example to show how good design can be used to retrofit low carbon living into old buildings, breathing new life into derelict buildings in more ways than one," said Rob Stoneman of the Yorkshire Wildlife Trust.

The Cre8 barn is being built using funding from Veolia Environmental Trust and will be an education centre for the many volunteers and visitors to the farm. With a communal kitchen, demonstration area and meeting space planned, the barn will accommodate both formal and informal education sessions, from school kids to trainees working towards accredited qualifications.

Green Building Store director Bill Butcher will be writing regular blogs about the project at greenbuildingstore.co.uk/enerphit. Members of the Passivhaus Trust and AECB, the company previously constructed the first traditional cavity wall building to gain passive house certification at Denby Dale, West Yorkshire.

(above) Work advancing at the Stirley Farm upgrade project, where the aim is to meet the Enerphit standard

SIP manufacturer expands business to meet demand

SIP Energy Homes, the Irish manufacturer of structural insulated panels (SIPs), is expanding its operations and capabilities to cater for growing and changing demand.

"We're in the middle of a whole bunch of changes here," the company's John Moylan told Passive House Plus, as they prepared to exhibit at Ecobuild.

Moylan said he is increasingly asked to produce thicker SIPs with better U-values. While 150mm would have traditionally been a common thickness, clients are now requesting up to 180mm, and in some cases 200mm, particularly in the UK market.

Moylan said that a 200mm panel will deliver a U-value of around 0.16 W/m^{2}K, but that they can also achieve much better U-values by installing an insulated service cavity on the inside of the wall.

But he emphasised the importance of airtightness, which he said was one of the main strengths of SIP systems. "We do find people dwell too much on U-values and not enough on airtightness," he said.

He said the company's factory-built system is particularly attractive in the UK, where short on-site construction programmes are often demanded.

The company has also recently added capability to make bigger panels — up to four metres high and spanning an entire length of wall. "Ceilings seem to be getting higher for one thing, but also joisting seems to be getting deeper," he said.

The company uses structural insulated panels for roofing too. "Because the system is homogenous – walls and roofs – it probably performs greater than the sum of its parts."

SIP Energy Homes recently built a new office facility in Athenry, Co Galway, and its roof has just five panels, Moylan said, minimising the number of joints that need to be sealed for airtightness.

The company has added more staff recently in design, production and administration, and have acquired a new articulated truck and crane.

"We do design, manufacture and installation as a single package," Moylan said. "For a lot of UK clients that's a big plus." Most of the company's clients are residential projects in the UK, he added, though the company works on larger buildings too.

SIP Energy Homes will be exhibiting at Ecobuild at stand N437.

(below) A SIP Energy Homes project with a curved roof

News

Internorm to present passive range at Ecobuild

Leading low energy window manufacturer Internorm has said it will present "one of the widest ranges of passive house and low energy windows and doors available" at this year's Ecobuild show in London. The company will also be launching a range of new products at the event.

Internorm's extensive offering includes uPVC and uPVC/aluminium windows in addition to timber/aluminium windows. The uPVC and uPVC/aluminium products have "excellent thermal performance" with U-values down to 0.74W/m^{2}K, the company said. Their timber/aluminium windows deliver U-values down to as low as 0.63 W/^{2}K.

The timber/aluminium range also offers a choice of spruce or larch interior finishes. Internorm also said the performance of their timber/aluminium windows is "enhanced by an innovative composite construction that incorporates a highly insulating thermal foam".

Internorm's windows also feature Solar+ glass, a thermal coating available on all their triple-glazed windows as standard. The company said that Solar+ triple-glazing maximises the potential energy gains provided through solar irradiation and prevents subsequent heat loss through the window.

Internorm's blind products include I-tec Shading, a specialist self-powered solar blind. The company has also recently launched its first RIBA-approved CPD, which provides architects with an "insight into building low energy and passive house standard properties in addition to how windows and doors play a significant role" in such buildings.

"Windows and doors are a key component of any building – they provide a function as well as having an aesthetical purpose," Internorm's Thomas Hagen said. "Getting the specification correct is paramount for the long-term benefits of the building. With our extensive experience, we are perfectly positioned in providing architects, specifiers and end clients the right advice in selecting the correct product."

Internorm will be exhibiting at Ecobuild at stand S1310.

Aberdeen office uses vacuum panels for ultra low energy result

When experienced modular builders D4 Development Ltd decided to build new offices on a tight Aberdeen site, they chose a solution that could combine energy efficiency and space saving: structural vacuum panels (SVPs).

The company developed a modular build system incorporating Nanopore's vacuum insulated panels (VIPs) into a timber frame to achieve exceptional energy efficiency without having to increase wall thicknesses for the new office.

Limited to a building width of 7.25 metres by a tight site, D4 director Stuart Duncan nonetheless wanted to build to passive house standards.

"I knew that to get wall U-values of around 0.10 w/m^{2}k was going to require thick walls," he told Passive House Plus. "I looked at many kinds of insulation but I couldn't justify having 500mm thick walls as it would simply use up too much internal space." Duncan turned to innovative insulation systems such as aerogels before deciding on Nanopore's VIPs.

As the name suggests, Nanopore's unique properties include nano-scale porosity. Combined with a vacuum sealed panel, the company says the material achieves five to six times the thermal resistance of conventional insulants.

According to Duncan, the need to maintain the integrity of each panel is best suited to factory production rather than a building site environment. The result was the SVP – a closed timber construction panel with a VIP at its core, encased with additional PIR insulation and further protected by sheet OSB. "This enables traditional fixings to be used without risk of puncturing the vacuum panel," he said.

"We added additional layers of PIR insulation to the SVP, so the final wall construction including plasterboard ended up at 188mm thick before the rain screen cladding was applied," he said. "By combining the SVP and PIR we ended up with a U-value of around 0.10 – not bad for a 188mm thick wall."

Duncan approached passive house certifier Peter Warm to see if the building –which was finished in December - could be certified, who told him that the building would struggle to achieve certification, principally due to a miniscule 55 sq m floor area. "PHPP seems to penalise small buildings," Duncan said, noting that the building either hit or exceeded many of the specifications typically associated with passive house, including wall U-values of 0.10 and window U-values of 0.7, and an airtightness of 0.42 air changes per hour (ACH) at 50 pascals.

(above) D4's recently completed office in Aberdeen; (inset) A cutaway section reveals the build-up of the SVP system used to build the office

News

Munster Joinery continues green growth with fourth passive certified window

Window manufacturer Munster Joinery now boasts four windows certified as passive house suitable components by the Passive House Institute.

"Passive house means a highly insulated building envelope which will achieve comfortable indoor temperatures without the use of a conventional heating system," said Munster Joinery's Marlene O'Mahony. "That means a maximum window U-value of 0.80 W/m²K. This places demands on window performance, with excellent frames and glazing needed to achieve the target." Munster Joinery's answer is to use triple glazing consisting of multiple panes of low emissivity glass, and optimum cavity widths filled with low conductivity gasses such as argon or krypton. Edge losses are reduced to a minimum by a warm edge spacer bar, and al frame sections have an insulating core and are designed so as to eliminate thermal bridging at all critical points.

"Passive windows are normally a huge part of the passive spend so the competitively priced Munster Joinery offering makes the passive proposition a lot more generally accessible," said O'Mahony. "The choice available to passive house customers has been limited in the past but the range of material, colour and operating system options we offer brings choice and versatility to the market."

Munster Joinery has grown since its foundation in 1973 to rate among the largest manufacturers of energy efficient windows and doors in Europe. Now operating in Great Britain, Ireland and Northern Ireland the company is a large employer, with a 230,000 sq ft manufacturing facility in Warwickshire and a further 910,000 sq ft production facility in Ireland. "Munster Joinery has the capacity to deliver passive products promptly," O'Mahony said.

And the company's sustainability efforts don't begin and end with its passive certified windows. "We employ efficient waste management techniques to reuse and recycle waste so that only minimal amounts go to landfill," O'Mahony said, adding that the company has invested heavily in green energy solutions. "Two wind turbines on our Irish manufacturing site provide 2.1 MW of electrical energy each, equating to an annual saving of over 9,000 tonnes of carbon emissions." The company uses a CHP plant with an output of 12 MW thermal and 2.8 MW electrical, fuelled by timber offcuts and sawdust from the joinery process. The company's purchasing policies also favour green materials – timber is responsibly sourced and the company has chain of custody certification to both FSC and PEFC standards.

(above left) One of two wind turbines at Munster Joinery's Irish manufacturing site; the company's manufacturing facilities in Ireland (top right) and England (bottom right)

Renovate Europe welcomes EU parliament's call for ambitious renovation targets

The Renovate Europe campaign has welcomed the European Parliament's call for the rate and quality of building renovation to be substantially scaled up in order to reduce the energy consumption of Europe's existing building stock by 80% by 2050 compared to 2010 levels. The call is contained in the parliament's report on the European Commission's Energy Roadmap 2050.

"Energy efficiency is a cost-effective way for Europe to achieve its long-term energy-saving, climate change, economic and energy security goals," the report says.

Renovate Europe said that the document recognises the huge energy savings potential and economic benefits which currently lie dormant in the EU's building stock, and that it reiterates the key role which energy efficiency must play in the EU's transition to a competitive low carbon, low energy future.

Achieving the reduction in energy demand of the EU's building stock by 80% by 2050 was already established as a cornerstone of the EU roadmap for moving towards a low-carbon economy in 2050, which was agreed in 2011.

"Aligning all actors, in the public and private sector, but also at consumer level, around the same goals of reducing the energy demand of the EU's existing building stock by 80% by 2050 is a fundamental step to achieving the EU's goal of a competitive low-carbon and low-energy economy by 2050," said Adrian Joyce, campaign director of Renovate Europe.

"The Renovate Europe campaign recognised this logical step in 2011, and set this target as the main vision of its campaign, with the aim of delivering jobs, growth and lower energy bills for EU citizens," he said.

The parliament's report also calls on the member states to fully implement the recently adopted Energy Efficiency Directive, and to adopt ambitious long-term building renovation strategies accordingly.

Renovate Europe is a campaign initiated by EuroAce, the European Alliance of Companies for Energy Efficiency in Buildings.

News

Aberdeen Maggie's Centre insulated with Icynene

GMS Renewable Products has completed the insulation of the new Maggie's Cancer Caring Centre in Aberdeen, Scotland with Icynene spray foam insulation. The building was designed by Norwegian architects Snohetta and local architects, Halliday Fraser Munro.

Gerry Sheridan of GMS Renewables said that Icynene was selected for the project's walls and roof for its "long successful history, comprehensive testing and certification, unique non-toxic properties and its ability to provide a complete insulation and air barrier in one application".

The structure of the building consists of a sprayed concrete shell finished on the outside with a unique white decorative DPM coating.

Icynene spray foam insulation products were applied directly to the underside of the concrete shell to a depth of 240mm in some areas to deliver U-values ranging from 0.13 to as low as 0.09 in some areas. The installation work was carried out by Icynene accredited contractor Building Insulation Services of Edinburgh.

The building has an airtightness of 0.6 air changes per hour (ACH). The internal finish is a smooth render system on EML with a DPM decorative coating finish.

The building's dome structure is approximately six metres high and will cover one ground floor level and a small mezzanine, with the building designed to maximise the capture of natural sunlight. Architects Snohetta say that the building was "conceived as a pavilion in a parkland setting".

(above) The Snohetta designed Maggie’s Centre has been insulated with Icynene insulation

Ecology Building Society offers mortgages for passive cohousing project

The UK’s largest new build project to achieve the passive house standard recently welcomed its first residents. The project was commissioned by a group of individuals in Lancaster who wanted to create a low carbon cohousing community.

The site on the banks of the River Lune just south of Lancaster, was purchased out of collective financial reserves. No borrowing was available to buy the site, as planning consent for changing the site's use from industrial into mixed housing with office space was uncertain.

A cohousing community is a type of intentional community composed of private homes supplemented by shared facilities. The community is planned, owned and managed by the residents. Common facilities may include a kitchen, dining room, laundry, child care facilities, offices, internet access, guest rooms, and recreational features.

One of the key components of securing development finance for construction of the Lancaster project was for the group to demonstrate that a lender would be prepared to provide mortgages to individuals within the cohousing structure, which the Ecology Building Society did.

Due to the nature of each property (and occupant) being an integral part of the cohousing community, securing such financing can often be problematic, as many lenders view such arrangements as too complex to lend on.

However, the Ecology Building Society has many years experience of lending to members of cohousing projects and other ownership structures that encourage shared resources and low impact living, and offers a 'C-Change' discount of 1% off their standard variable rate on all homes built to the passive house standard.

(above) The Lancaster cohousing project under construction

News

Ancon to show award-winning low energy fixings at Ecobuild

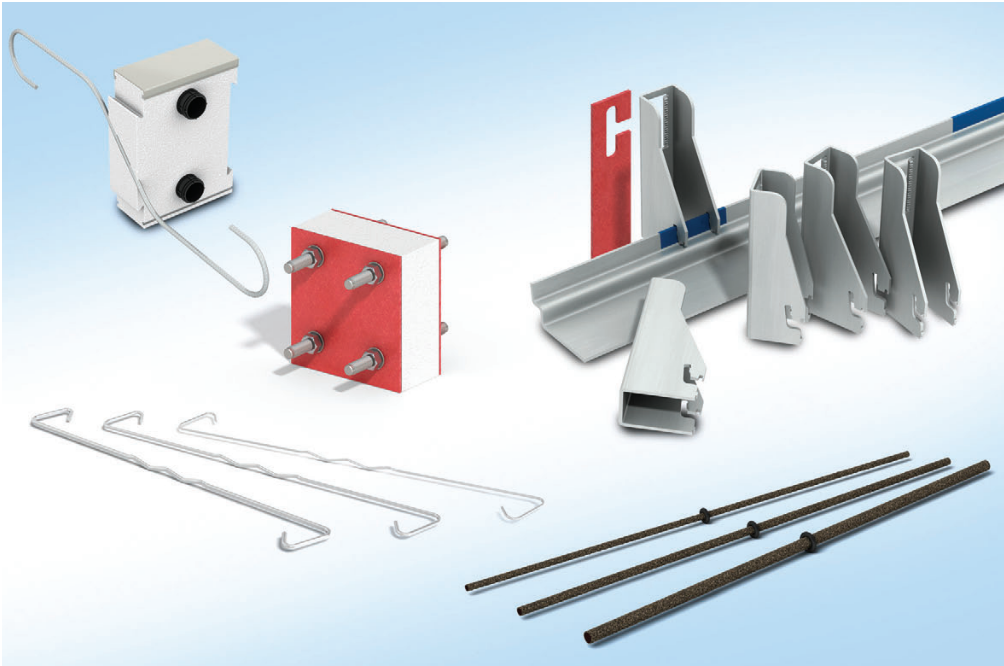
Queen's Award winner Ancon Building Products, will showcase innovative structural fixing solutions that the company claims are helping to change the way that sustainable low energy buildings are designed and constructed at Ecobuild 2013 from 5 – 7 March.

The company said that products on show will include low thermal conductivity cavity wall ties, such as the Ancon TeploTie, an innovative basalt-fibre tie used in many ground breaking low-energy developments; and the new Staifix RT2 275mm, the first high thermal performance type 2 stainless steel wall tie to enable the use of 150mm wide insulated cavities in multi-storey low energy construction.

Also featured will be a range of Ancon Thermal Breaks, designed to reduce thermal bridging at balcony connections, brickwork support brackets and other areas where thermal continuity of the building envelope is typically compromised.

Completing the displays will be Ancon's more established solutions, including support angles, windposts and masonry reinforcement, which Ancon said feature "the same low thermal conductivity, 100% recyclability and long, maintenance-free life associated with all of the company's market-leading stainless steel products."

In addition to a Queen's Award in Innovation, Ancon's latest success came in the 2012 Build It Awards, where the TeploTie was voted 'Best Innovation in Insulation'.



The TeploTie has already been used in a number of prestigious low-energy projects, including Denby Dale – the first certified UK passive house to use traditional masonry cavity construction – and the first zero carbon retrofit to achieve level six of the Code for Sustainable Homes.

Helping to open the door for traditional masonry super-insulated homes, the TeploTie is manufactured from an "innovative composite material with a thermal conductivity so low it can be totally excluded from EN ISO 6946 U-value calculations," the company said. This enables target U-values to be achieved using thinner, more efficient wall constructions.

Ancon will be exhibiting at Ecobuild at stand N1110.

(above) The range of energy savings fixings Ancon will be exhibiting at Ecobuild 2013

Consider custom airtightness tapes for low energy buildings — Isocell

Insulation and airtightness expert Isocell has advised anyone involved in building projects to consider custom airtightness tapes.

"Isocell's comprehensive range of custom and standard products eliminate the need for makeshift, less suitable products," said Isocell's Stuart Prause.

The company offers a large professional selection of membranes, tapes, grommets, EDPM rubber seals, butyl and alu tapes, sealants, compressed joint tapes, specialised high grade diffusion open foam, as well as primers and adhesives for achieving air and wind tightness in new build or renovation projects regardless of the build make-up.

"The combination of the Isocell Omega wind tight system, cellulose fibre insulation, and Isocell Airstop system ensures a perfect solution that works in harmony," Prause said.

Prause said that the Isowindow system is customisable in width, which means that as well as meeting traditional depths, it can cater for the deeper reveals commonly found in low energy and passive structures. "Isocell is the first company to offer custom width tapes of this nature as required on demand to the Irish and UK markets," Prause said.

He added that the company's window system has been a favourite in school projects across Ireland, helping specialised certified Airstop system installers such as Airstop.ie achieve what Prause said were the "best results in airtightness in any school during 2012". He added that the Isowindow system is particularly suitable for masonry buildings.

Isocell have over 23 years' experience in manufacturing and developing airtight products. Prause said that Isocell is a European leader in its field and number one in many countries, including Austria, where the company was founded. Isocell's projects in Ireland have included certified passive houses, plus Northern Ireland's first "carbon neutral" home. The company also supplied the new £50 million Glasgow School of Art building with specialised membranes sealants and adhesives.

Prause said that Isocell is the chosen airtight solution provider to some of the largest construction and window companies in Ireland and the UK including Munster Joinery, Duggans Window Systems, Eco Timber Frame Cork and Stewart Milne Timber Systems, the UK's largest timber frame provider. The company also offers support, training and back-up.

(below) an illustration of Isocell's Isowindow tapes, which come in customisable widths

Building? Upgrading?

Passive House Plus is here to help!

Are you designing, building or pricing a sustainable building? Whether it's an energy upgrade of a small house, or you're looking to achieve high green standards with a new home, office or factory, Passive House Plus can help.

Fill in your details below, or online at www.passivehouseplus.ie & your enquiry will be sent to the Passive House Plus advertisers that provide the products or services you need. If you fill out your postal address we'll even send you the next issue of Passive House Plus free of charge!

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name: ____________________

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Site location (please list county): ____________________

Project type (tick box)

New home ☐ Home renovation/upgrade/extension ☐ New commercial/public building ☐
Upgrade/extension to a commercial/public building ☐

Other (please state): ____________________

Floor area (approx. ft^2 or m^2): ____________________

Budget (approximate): ____________________

Stage (tick box)

Initial appraisal ☐ Pre planning ☐ Planning approved ☐ Pre tender ☐
Commencement notice ☐

Project imperatives (tick box)

Certified passive ☐ Near passive/low energy ☐ Indoor air quality ☐ Low running costs ☐
Low environmental impact ☐

Other (please state): ____________________

Estimated start date (please state): ____________________

Just tick the products/ services you would like more information on:

- Airtightness & draught-proofing products ☐
- Cavity wall ties ☐
- Cladding / renders ☐
- Combined heat & power ☐
- Conferences, workshops & shows ☐
- Demand-controlled ventilation ☐
- External insulation ☐
- Heat pumps ☐
- Heat recovery ventilation ☐
- Insulation ☐
- Passive house & low energy build systems ☐
- Passive house consultants / designers ☐
- Solar photovoltaic ☐
- Solar thermal ☐
- Structural insulated panels ☐
- Sustainable building contractors ☐
- Sustainable mortgages / ethical finance ☐
- Thermal breaks ☐
- Timber frame ☐
- Windows & doors ☐
- Wood burning stoves ☐

I would like my project to be considered for feature in Passive House Plus (tick box) ☐

Life in the UK's first passive house

*In 2008 Y Foel – the UK's first certified passive house – was completed, a highly ecological timber building in Machynlleth, mid-Wales. Owner **Mark Tiramani** shares his experience of living in a pioneering green building.*

Our first beer mat sketches of Y Foel were for a small house with load-bearing straw bale walls. No matter how much the design changed over the next six years one thing remained clear: The main structure should be built of stuff that could either be re-grown or was recycled, or a locally sourced natural material. We mostly stuck to that principle.

The final structure was built using wooden I-beams with wood fibre board on the outside and OSB for racking strength on the inside. This created a hollow wall with a 300mm cavity and a roof with 400mm cavities. For us there were only two possible candidates for the in-fill: recycled cellulose fibre or Welsh sheep's wool.

"Back in 2008 I was a little sceptical as to whether all the theory would add up to a functional whole"

After nearly four summer-winter cycles I am sure we made the right choice by going with Warmcel.

The generous south-east corner glazing was a key part of the project. However, it came at a price: The risk of summer overheating, and increased night time heat loss. To compound things it is a modestly sized detached structure with a relatively high surface area to volume ratio. If we were to achieve passive house certification the opaque elements of the structure would have to perform exceptionally well.

The wall structure would have to have excellent insulation in both directions. The combination of five tonnes of Warmcel in the walls (and roof) and 60mm of Unger wood fibre board sheathing produced a structure that is exceptional at keeping the heat in during winter and also at fending off excess heat during the summer.

The low diffusivity of the wood fibre board and Warmcel, combined with relatively high density and specific heat capacity, means that the time it takes for the hottest summer sun to penetrate to the inside of the wall is delayed all the way into the night (long decrement delay). Although the main load bearing structure would generally be classified as "light-weight" it suffers none of the overheating problems of conventional wood-framed houses. We also love the fact that the structure takes high humidity levels in its stride. We are in the beautiful mid-Wales hills and have recorded roughly 2.3 metres of rain in the last 12 months.

Late on in the build we decided to add additional thermal mass to the inside of the building: In total we have approximately 40 tonnes of earth blocks, slate, mortar and a thin concrete slab. This responds quickly on sunny days, even during spring and autumn, soaking up excess heat and then feeding it back at night.

The 1st floor 250mm I-beam cavity is also filled with Warmcel. This adds to the slow response thermal mass of the interior and has excellent sound dampening characteristics.

Back in 2008, I was a little sceptical as to whether all the theory would add up to a functional whole. I need not have worried: The house is now being monitored through its 4th summer-winter cycle. It significantly outperforms its PHPP calculations for space heating and the overheating frequency is minimal.

Passive house has been a revelation. And whilst we always loved wood we now have a much deeper appreciation of its extraordinary versatility.

Facts and figures:
Average annual space heating for 2010, 2011, 2012: 12.4 kWh/m^2/yr
Summer overheating frequency: <2%

For more information on this building visit: www.passivebuild.co.uk

Letters to the editor

What are your thoughts on the sustainable building issues of the day? From the next issue of Passive House Plus on we'll be publishing readers' letters on this page.

Email letters@passivehouseplus.ie or write to us: Letters to the editor, Passive House Plus, Temple Media Ltd, PO Box 9688, Blackrock, Co Dublin, Ireland.

Your comments may be edited.

(right) According to Tiramani Y Foel has been a resounding success over the past four summer-winter cycles

Why passive house should replace flawed zero carbon aims

*While it's important to assess all aspects of a building's environmental impact, UK efforts on sustainable building have tended towards box ticking – often at the expense of true sustainability, argues **Jonathan Hines** of award-winning architects Architype.*

"Carbon targets encourage the design of less, rather than more efficient buildings"

Passive house and standards such as building regulations, the Code for Sustainable Homes, and BREEAM (the BRE Environmental Assessment Method) were developed for different purposes and consequently have fundamentally different aims.

In the UK standards like this were designed to meet 'top down' political aspirations – currently a broad range of environmental issues, including water and waste, but most significantly 'zero-carbon' building targets.

Passive house was developed from the 'bottom up' by building physicists seeking effective ways to design low energy buildings and ensure that they perform as predicted, in response to evidence that they were not. Passive house has a simple aim – to use good design to achieve optimum internal comfort for the lowest possible energy consumption.

It isn't possible to say that passive house is the equivalent of a certain code level or vice versa. Whilst the heat loss of passive house meets the heat loss parameter requirement for level six – the highest level in the Code for Sustainable Homes – a house designed to meet any code level, even six, won't meet the passive house energy standard. Given the code's zero carbon targets, passive house can't achieve level five or six without adding renewables.

Rather than trying to calibrate between such different standards, it's more useful to highlight discrepancies.

Zero-carbon buildings – a flawed target?

I believe the core idea of the code and regulations, that buildings are perceived as isolated 'zero-carbon' islands, is conceptually flawed.

Firstly, it's based on 'offsetting' carbon emitted by continued energy consumption, rather than actually 'cutting' the emission of carbon by reducing energy use.

Secondly, it requires renewables on buildings despite the reality that these are generally less efficient and less economic than renewables at a community, regional or national scale.

Thirdly, carbon targets encourage the design of less, rather than more efficient buildings. The easy option of adding renewables or changing the heat source enables poor design to achieve compliance, regardless of whether the renewables or specified heat source are actually used.

A more effective strategy to reduce national carbon emissions would focus on improving building design to reduce energy consumption regardless of heat source, and separately generating low carbon energy on the most effective and efficient scale.

That is what passive house offers – a rigorous way of designing efficient buildings that consume less energy.

Broad issues

To ascertain overall environmental ratings, BREEAM and the code give universal weightings to very different factors. This can result in anomalies, and the addition of features in order to score points that are inappropriate for that particular building.

For example to achieve code level five or six most dwellings require rainharvesting or greywater recycling even when this increases carbon emissions or is sustainably questionable. Cycle racks, nearby shops and considerate contractors are important, but should they offset more energy efficient building design? Money can be spent on tick box procedures, rather than actually improving building performance.

Being based on achieving a percentage carbon improvement compared to a notional base building, the UK Building Regulations encourage inefficient design. With a poor base design you can more easily achieve notional improvement and compliance. By setting an energy target per square metre per year for all buildings, passive house eliminates this anomaly. Buildings then have to be designed to reduce energy.

Accurate prediction

Compared to passive house, Sap – the UK software to demonstrate Part L compliance and generate energy ratings – uses optimistic assumptions, including over-generous incidental internal gains and underestimated heat losses for thermal bridges. This results in inaccurately low predictions of required thermal energy and reduces the incentive to improve design, making it a poor design tool.

Passive house uses pessimistic and cautious assumptions, which makes compliance harder and incentivises design improvements over and above other measures. Developed through many years of real life monitoring, it allows for the fact the built reality will fall short of estimated theory, and achieves buildings that perform as well or better than predicted, making it an effective design tool.

Conclusion

The broad box ticking environmental aims and zero-carbon targets of UK standards encourages contradictory solutions and complex design. The radically low energy target of passive house, and its rigorously accurate process, encourages simple solutions and integrated design.

Because passive house aligns with Architype's long standing belief that the basic architecture should, by design, do all the hard work in saving energy, we have integrated passive house into our standard design approach.

In 2009, St Luke's in Wolverhampton was the first primary school in Britain to achieve BREEAM Excellent. We've now completed three certified passive house schools and have a further school currently on site. We've just received planning approval for the UK's first passive house archive building, have submitted the planning application for a major new passive house building for the University of East Anglia, and this month we'll be submitting the planning application for a scheme of 150 passive houses in Herefordshire, for which we've formed a new development company called ArchiHaus.

We're committed to passive house because it offers greater long term financial benefits to our clients, a more comfortable internal environment for users and, most importantly, more effective long term energy and carbon reductions.

Our experience and belief is that passive house does offer a logical, robust and affordable solution for all building types, given the requirement to reduce carbon emissions and in the context of the current economic climate.

Instead of relying on expensive and add-on technologies to offset carbon, it encourages buildings that simply save energy by design. We've been achieving this at no extra cost in a variety of different projects, through integrated thinking and a relentless focus on simplicity of design.

With budgets under increased pressure, particularly in the education sector, achieving passive house at no extra cost is increasingly hard to achieve. However, once whole life costs are considered passive house wins hands down, with capital payback in as little as five years, and significant revenue savings for the life of the building with future proofing against ever increasing energy prices. This would release far more money in the long term to spend on teaching, than squeezing standards and fees in the short term.

How to get green detailing right in refurbishments

*If the Green Deal delivers on the rhetoric, the UK building stock will be retrofitted on an unprecedented scale. Green Register director **Lucy Pedler** describes a seminar series designed to provide timely advice to prevent costly mistakes from being made.*

Since June 2010 we've been running our Eco-refurbishment and The Green Deal seminar, where 'warts and all' presentations of residential case studies give delegates in-depth information on how to retrofit their buildings in a sustainable, low carbon way. But one of the frequently asked questions raised in these seminars is 'what are the risks of interstitial condensation when applying insulation to an existing building?'

As the economy plummets but fuel prices soar, construction professionals are increasingly working on upgrading their clients' properties rather than new build projects but are very concerned that by adding roof, wall and floor insulation they risk moving the dewpoint, causing moisture to accumulate within the fabric of the external envelope. This can cause damp to build up, mould to grow and potentially damage to the fabric – or worse still, structure – of the building elements. Alarm bells start to ring. No professional wants to be faced with a possible lawsuit for negligent practice.

> "No professional wants to be faced with a possible lawsuit for negligent practice"

Other concerns repeatedly raised in our eco-refurbishment seminars include: "Which is the best way of insulating an existing external wall – inside, outside or the bit in between", "How can I achieve airtightness when refurbishing buildings?" and "How can the design team and builders effectively communicate to achieve best practice detailing?"

As always The Green Register loves to respond to delegates' requests for more, unbiased information. We decided to tackle these issues head on by running All in the Detail – achieving Best Practice Detailing for Eco-refurbishments, a series of new seminars around the UK.

We've run these four times around the UK with high attendance in all locations. We chose speakers for each seminar with in-depth knowledge of eco-retrofit projects – experienced practitioners who could share some of their practical experiences of building airtight, well insulated refurbishments but with little or no risk of interstitial condensation.

The first – and judging by the delegates' feedback by far the most well received – speaker was builder Rafael Delimata, director of Bowtie Construction, contractors with a passion for sustainable building. Rafael used a combination of teaching techniques to explain how his company has consistently achieved best practice detailing in retrofits. Using full size construction mock-ups of wall and roof junctions he had made especially for the seminar, Rafael illustrated how to achieve very stringent airtightness standards and the challenges of ensuring continuous, unbroken layers of insulation, vapour checks and breather membranes.

Rafael also used videos to demonstrate examples of difficult detailing such as at roof hips and valleys, dormers, window and door reveals. Architects' drawings were displayed (anonymously of course!) to show where detailing was tricky and how better communication – both through drawings and between site managers and operatives – would achieve better standards of airtightness and insulation.

The best thing about Rafael's presentation was that he could prove that his retrofit jobs actually worked using a combination of careful site practices, good communication and a thorough understanding of the technical information on tried and tested building products.

Finally, Rafael addressed the thorny issue of the cost to install low impact building materials, hidden costs like wastage and storage, delays if products need to be reordered and how builders save money compromising on quality or using substitutes.

The next speaker was Joseph Little of Building Life Consultancy who used his extensive research and experience as an architect to discuss healthy, breathable materials and moisture control in existing buildings. Joseph covered topics such as the consequences of adding insulation to external elements (particularly when it's non-breathable), the limitations of the Glaser method, and the risks of moving the dewpoint and trapping airborne moisture in elements of a retrofit project. Joseph's thorough analysis of the problems airborne moisture can cause were very much appreciated by the audience, many of whom were practitioners themselves.

Andy Mitchell and Valentina Marincioni from NBT shared some fascinating research they're working on with University of Central London on moisture movement in buildings. Valentina explained that there are three key principles to delivering low energy refurbishment solutions through the building fabric: thermal coherence, airtightness and moisture control. In order to ensure that a fabric solution is delivered correctly, NBT have developed a material system based approach and Valentina outlined the importance of one of these areas, fabric moisture control and the use of Wufi moisture modelling software to assist in the retrofit design process. The research shows that it's a very complicated subject and that Wufi takes into account subtle differences such as location, orientation and even different types of bricks. Andy illustrated the importance of using breathable materials to avoid interstitial condensation.

Our final speaker was Jean Pierre Wack, director of Eight Associates, who used an extremely interesting case study of a passive house standard retrofit to a house in London to demonstrate quite how far we would have to go to achieve such exacting results.

With The Green Deal's somewhat underwhelming launch in Autumn 2012 this seminar could not have been more timely. It helped construction professionals understand the complexities of introducing green measures into existing buildings – something we are going to have to increasingly get our heads around as the impacts of climate change on our poorly performing building stock become evident.

For more information about The Green Register including all forthcoming events visit www.greenregister.org.uk

If it's not a passive house, don't call it a passive house

*Unlike popular terms like eco, green & sustainable, passive house has a specific meaning & shouldn't be used incorrectly, argues Passivhaus Trust technical director **Nick Grant**.*

> "Passive house principles can't be used loosely to mean a passive house flavoured building"

The recent rapid growth of Passivhaus (referred to as passive house from here on as per the editor's request) in the UK and Ireland has been a game changer. The number of buildings is still small but we already have multiple examples of detached homes, terraces, blocks of flats, offices, community buildings and primary schools. Most are performing embarrassingly close to the predicted energy and comfort targets. This is a statistical anomaly of a small sample but it's still impressive given the consistently poor performance of most earlier attempts at energy efficient building. This is one of the reasons for getting excited about passive house – it seems to work.

However I expect this wave of excitement to pass. Anyone jumping on the bandwagon soon realises that it requires effort. The first project is particularly challenging because the passive house approach requires attention to detail and is very different to what we are used to. There is an awful lot to learn. Mistakes will be made.

This typically leads to one of three responses. 1) don't do it again, 2) cherry-pick the easy bits and call it something apparently non-committal like 'passive house principles' or 3) embrace it, learn from the experience and find ways to make it easier next time. Some who have embraced the challenge decide to only take on passive house projects. These people realise that passive house is a whole approach, not just another thing to offer clients alongside zero carbon, LEED and BREEAM – they can't unlearn what they now know.

Passive house principles and fruit flavoured drink

One of the great things about passive house is that it's defined. 'Low energy' or 'eco' are worse than meaningless terms. One person's green exemplar might be someone else's nomination for a Mark Brinkley Eco Bollocks Award. By contrast it isn't difficult to check the claim that a building is a passive house. The Passivhaus Trust document Claiming the Passivhaus Standard[1] clarifies what it means to claim a building is a passive house. It is already having an influence internationally and the Passive House Institute has asked to translate it into German. If you are involved in passive house then you need to read it. If you find fault then help us improve it.

Passive house is an open standard and the term is not registered. But because it's understood to mean something specific, to describe a building as a passive house is to make a very unambiguous claim under consumer law. If you buy red shoes online and they arrive as blue you can claim your money back. What you've built may be better than passive house but if it doesn't meet the quality assured definition then you need to call it something else.

But what does it mean when people say that they couldn't afford to achieve passive house but are following passive house principles? Surely following the principles should result in a passive house. To my mind an acceptable use might be to describe a building as, say, 'built following passive house principles but achieving a PHPP-calculated annual heat demand of 21 kWh/m^2/yr with a blower door result of 1.1 air changes'. It's almost a passive house but for some reason we just missed the mark and are being transparent about our claim. In marketing terms straight passive house is a simpler story – and a simple term for honest near misses would be useful. But passive house principles can't be used loosely to mean a passive house flavoured building.

I am reminded of this quote:

"I was working as a physicist. I read that the construction industry had experimented with adding insulation to new buildings and that energy consumption had failed to reduce. This offended me – it was counter to the basic laws of physics. I knew that they must be doing something wrong. So I made it my mission to find out what, and to establish what was needed to do it right." – Dr Wolfgang Feist, founder, the Passive House Institute

15 years ago I had experimented by building our home using what I thought were passive house principles. The foundations are thermal bridge free, airtightness was 1.3 (n50). Insulation is continuous 400mm in walls and roof. Ventilation is passive to avoid the electricity to run fans, and heating is by a single woodstove with no radiators. I have seen arguments that lesser buildings than this are better than passive house so surely we can say we have followed passive house principles or even gone beyond them? But no, the 'passive house community' won't let us join their exclusive club!

Now that I know PHPP well, I'm pleased that they won't let us call our house a passive house as I have to report that our house's heat demand weighs in at around 90 kWh/m^2/yr, six times that of a passive house. It gets worse: performing an expensive retrofit with passive house windows and heat recovery ventilation would only get our heat demand to around 50 kWh/m^2/yr. If I wasn't able to point to other even worse eco-exemplars on a weekly basis I might be too embarrassed to share such an apparently spectacular failure. Had we modelled this building in PHPP it would have been immediately obvious that the problem is the form. Any experienced passive house designer would know it's not ideal but only the most experienced would guess how bad our lovely house is in energy terms. This isn't a passive house problem; it's a law of nature problem. Whilst most visitors experience our home as warm and comfortable, a passive house dweller would be less than impressed.

So if what you are designing, building or selling is not a passive house, then call it something else. Otherwise it causes confusion, annoys the passive house community and is probably illegal.

[1] http://bit.ly/RWni95

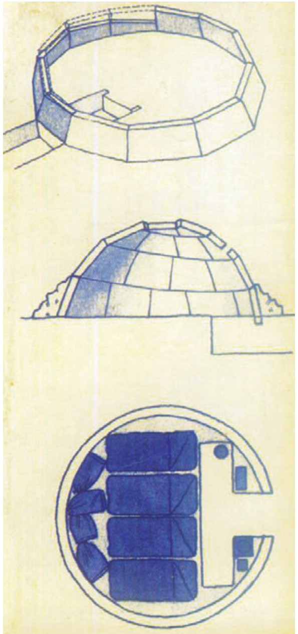
International selection

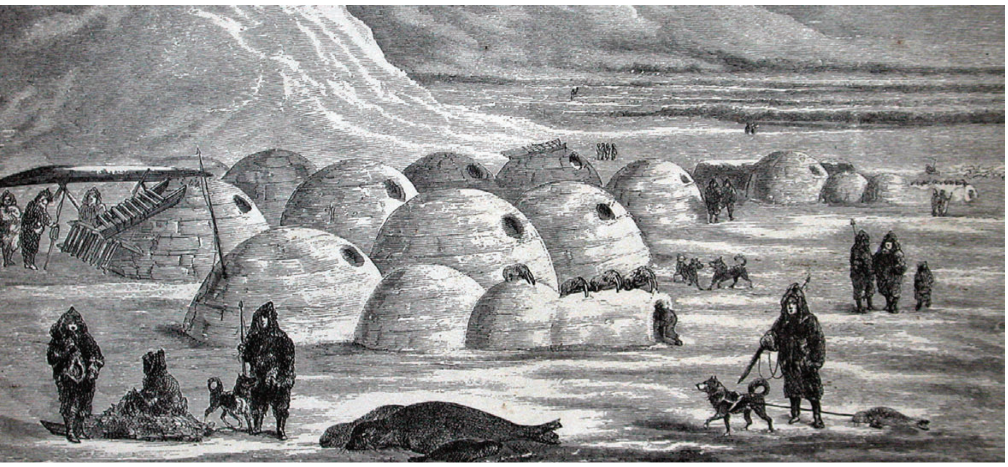
what we can learn from **igloos**

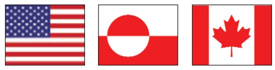
Nothing drives innovation like adversity. Facing up to the prospect of scarce energy and other resources, we can take inspiration equally from the Inuit and the most avant-garde of passive house designers, as **Sofie Pelsmakers** reveals in her choice of six uniquely inspiring buildings from around the world.

I believe that all good architecture should also be sustainable architecture and I hope that my selection of buildings illustrates this very point. The six dwellings I have chosen inspire me for several reasons: from the Inuit's igloos as bare shelters with minimal impact to advanced passive house buildings. They share some remarkable strategies such as reliance on body heat for internal heat-gains and good airtightness and – in the case of the Just-K passive house – also the utilisation of the natural stratification of air. Le Corbusier's 1950's Maisons Jaoul with Catalan vaults and rough brick is not well known but well-loved by its current inhabitants (two families with young children, since you ask). Like the majority of buildings at the time, the Maisons Jaoul are uninsulated apart from double glazing, but use the local site context and the European material vernacular of brick and oak beautifully. Pushing the local vernacular and local material opportunities further are Geoffrey Bawa with his tropical, bioclimatic modernism in Sri-Lanka and the sublime Tyin Tegnestue with their architecture of necessity, built with and for local communities with limited resources.

I think my selection of these projects gives away what inspires me most: buildings which quietly mitigate and adapt to climate change, which use local materials and skills intelligently while drawing from local knowledge, skills and techniques. I particularly get excited by those projects which use contextual parameters to generate their design rather than see it as a straitjacket for creativity, and all projects presented here do exactly that, though each in very different ways. But I also believe, just like the Inuit when constructing igloos, that we have to gain a deeper knowledge and understanding of locally available materials and construction sequences and techniques for how we design and build.







Igloos, the North American Arctic

Igloos were temporary hunting shelters built by the Inuit population in northern Alaska, Greenland and Canada, and are only sporadically used. Igloos are built from local and renewable materials with just a knife for cutting and shaping and can be erected by two people in less than two hours for a night's shelter to two days for a larger one, where several igloos of different sizes are connected to provide more space and greater comfort. They are built from 20 cm thick snow-blocks, cut out with a knife from the snowy ground surface. To do this, sufficient snow depth is needed, so blocks can be cut out of the surface and lifted out, leaving the igloo's floor one snow-block below the external 'ground' level.

The first snow-block layer is put in a circle and its height cut down to a sloping spiral before placing the next layer of snow-blocks, giving it inherent strength. The igloo can then be built entirely from the snow found within its 'circle'. Light can be allowed in when using ice-blocks instead of opaque snow-blocks.

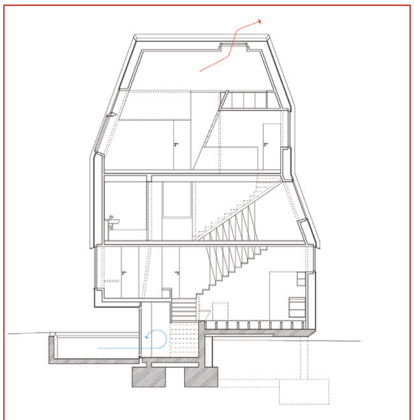
Airtightness is crucial and blocks are shaped with a knife to create tight joints between them. Once all the snow-blocks are in place, cracks are plugged with snow from the outside. The effect of breathing inside creates an ice layer and an airtight layer while also strengthening the structure. Natural stratification allows the warmer air from people's bodies to move up into the main igloo space at the top, which is used for sitting and sleeping, often made comfortable with animal skins. A very small gap at the top is allowed to replace CO_2-laden air with fresh air from a small hole under the lower level entry tunnel, which is closed with a snow-block. Due to the air-pockets in snow, it acts as an insulator in a harsh environment. This combined with a small, compact space and body heat in an occupied igloo, creates relatively warm internal temperatures of around 15C. Though much below the thermal comfort that we have come to expect from our dwellings at present, this is an impressive increase from external temperatures which are several degrees below zero.

Yet the lessons from igloo-building are relevant, but often ignored, in today's construction in cold climates: the importance of airtightness, wind protection, dwelling occupancy and harnessing of internal heat gains. Too often have we allowed the outside in when it is not desirable and we still are bad at providing protected lobbies or wind-shelter. Igloos also teach us lessons about the use of local materials, construction techniques and knowledge, unrivalled by most architects or builders. Architects are generally removed from the construction process, while builders seem to build each house as a one-off prototype, not able to take forward knowledge and skills gained. ▶

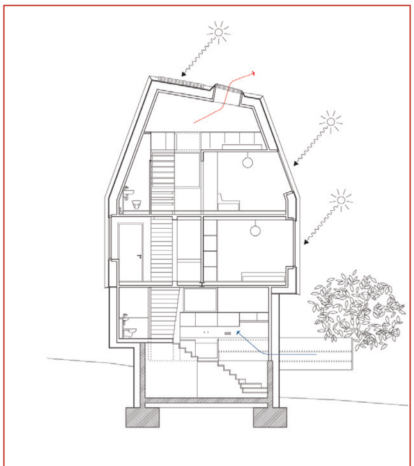
(clockwise from opposite) Inuk hunter, Avataq, in polar bear trousers, lights stove inside an igloo in northwest Greenland; Qaaviganguaq Qissuk, an old hunter Inuk uses a snow knife to build an igloo in northwest Greenland; a diagram showing how the sleeping area is raised above the entrance so that it retains any heat as hot air rises; an Inuk inside an igloo, circa 1900 – 1923; a community of igloos (Illustration from Charles Francis Hall's Arctic Researches and Life Among the Esquimaux, 1865)

Photos & illustrations (from top): Bryan and Cherry Alexander Photography; Justify1966; Canadian Geological Survey

Photos: Brigida Gonzalez / brigidagonzalez-projects.de



Schnitt A-A/ Section A-A



Schnitt B-B/ Section B-B

Just K, Tübingen

Just K was designed by Amunt Architects in Germany for a family of six people. Just like the igloo, the living spaces are at the top, and natural stratification ensures that these are the warmest spaces in winter. As in igloos, good airtightness is crucial to reduce heat-loss through cracks and the passive house standard has been adhered to.

Its sculptural form was generated from its contextual and constricted site conditions, such as needing to allow original views from neighbouring dwellings to the vista's beyond. An efficient building fabric was achieved partly by prefabrication and high levels of insulation, as well as solar gain to harness the free heat and light from the sun, while the sculptural form leads to a vertically connected open space within a limited volume. The house can be split into two apartments and is built almost entirely from locally sourced timber and prefabricated in a local factory with a total of 136 pieces site-assembled.

The structural engineered timber has been left bare internally, providing a warm and architecturally interesting interior, while adding significant thermal mass to the fabric. The use of timber and vertically connecting spaces with strategically placed openings, creates a fluid interior. Its spaces resemble something very different from what we have come to think of as highly efficient dwellings and is hence inspirational in breaking this mould. ▶

Images: A2M Architects

Haren 02, Brussels

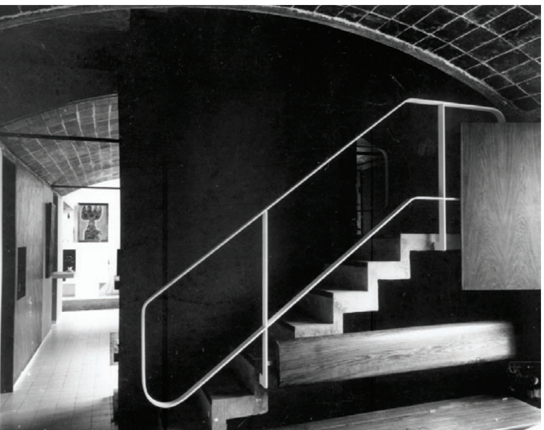
A re-interpretation of the efficient 'box' is also what A2M Architects did in Haren 02, which is a residential scheme of 30 passive house dwellings in the north east of Brussels, where from 2015 all new buildings will need to meet the passive house standard. The architects took great care to design its urban form and generated 'urban breaks' – a vertical stepping of buildings to break regularity and allow for a less imposing street front. They also allow for solar gain and views to internal and external spaces beyond, while creating accessible roof terraces for residents. Rather inspirationally, the architects consciously decided a few years ago to only accept passive house commissions as they believe this is simply common sense. They also undertake all of the building physics and technical modelling themselves rather than outsourcing it, thereby creating a local hub of knowledge in their day-to-day practice.

Haren 02 is currently on site, and is likely to be a game-changer for passive house in Europe and elsewhere for several reasons. Firstly, the project is projected to cost around 15% less than standard housing construction, achieved by prefabrication and as much off-site construction as possible to avoid wet trades and speed up construction to around seven months. Secondly, Haren 02's projected primary energy use is just 45 kWh/m^2 per year – due to its passive house specification and some on-site renewable energy delivery. Once completed, the performance will be monitored. In addition, some of the dwellings are 'zero energy' prototypes, illustrating that energy efficient buildings require less energy. Indeed, it is much easier for the remaining energy requirements to be met with renewable technology, whether on or off-site, in efficient buildings.

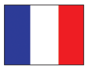
Finally, Haren 02's airtightness strategy is potentially more robust and longer-lasting: it relies on the use of prefabricated concrete panels without the need for airtightness membranes or tapes (joints will be siliconed instead, however the longer term performance of this approach is unconfirmed). Such thinking may spur the construction industry to go further still in working with the inherent qualities of materials to achieve airtightness more naturally, so watch this space.

Photos: ©FLC/IVARO, 2012

(above and below) the combination of traditional and modern evident in the Catalan vaulted ceilings, thin load-bearing walls and sculptural stairs; (top) the uninsulated walls and primitive double glazing make the building difficult to keep warm



Maisons Jaoul, Paris



In principle, I normally only write about buildings that I have visited: there is no substitute for spending time in a building to experience and judge its qualities such as its scale, volume, fluidity and changing light conditions and to gain a sense of how the building is used and has weathered. However, the only buildings included here which I have visited are the Maisons Jaoul by Le Corbusier, in the outskirts of Paris.

The two Jaoul family houses are far removed from Le Corbusier's earlier and well known designs such as Villa Savoye or Maison La Roche. The Jaoul houses were designed in the early 1950's, in Le Corbusier's more mature years, and it shows: the use of primitive techniques combined with modern technologies such as thin Catalan vaults on thin load-bearing and rough brick walls with exposed rough concrete, bright colours and plenty use of timber and sod roofs. In fact, there are no external super-smooth white finishes in sight at all.

The vaults act as central hearths and refer to primitive human habitations and shelters and were regularly used by Le Corbusier in his later dwelling designs. The placement of the two houses on the constrained and overshadowed site were generated by Le Corbusier's search for the greatest amount of exposure to sunlight and daylight penetration. Typically, the windows sit in window sections ('pans de verre'), with glazed sections for day-and sunlight and opaque timber sections to provide ventilation openings and built-in furniture. Internal timber wall panels also act as 'aerateurs' to provide fresh air, located between spaces to allow for cross ventilation, while retaining privacy. Moving timber shutters keep the heat in on cold winter nights and make the house light or dark and all stages in between. One of the houses has beautiful rainwater spouts and some innovative L-shaped windows were developed in response to strict bylaws. A tile is cast in the original tiled floors with instructions to occupants for how to maintain it, a front-runner to occupant user-manuals, if you like.

Unfortunately the early double glazing failed and the current occupants say it is difficult to keep warm in a cold winter as it was built before insulation, thermal bridging or high thermal comfort standards mattered. Yet the Maisons Jaoul signify an important shift from Le Corbusier's much earlier work and are a departure from the generic, standardised international modernism to a more regional and contextual approach that most do not remember the iconic architect by. This maturation was inspired by his interest in the local vernacular but also by learning and responding to building feedback and mistakes, something all designers should be doing. ▶

Photos: Dominic Sansoni / threeblindmen.photoshelter.com

Ena Da Silva house, Colombo

Geoffrey Bawa was influenced by international modernism and Le Corbusier's early work and in the late 1950's designed tropical 'modernist' buildings in Sri Lanka, though little known outside South-East Asia. While white, reflective surfaces suited a hot, humid climate, Bawa soon realised that pitched roofs with large overhangs rather than flat roofs were better to deal with torrential downpours, keep the sun out and to encourage natural ventilation.

From his interest in Sri Lanka's architectural heritage and building traditions, Bawa developed tropical courtyard designs with open spaces around them to aid natural airflow and the Ena Da Silva House, built in 1960, is an example of this. It signifies Bawa's deeper understanding of local climatic conditions and material use and blends modernity and tradition. Pitched roofs are tiled with traditional materials while timber trellises provide screened views across the courtyard. Inside and outside spaces are blurred, giving the feeling of infinite space and providing a good cross flow of air. Bawa beautifully builds on the local vernacular, utilising principles of cross flow of air, courtyards and shading, to provide modern, bioclimatic architecture with spaces that work and are inspirational. ►

Soe Ker Tie House, Tak Province

Norwegian architects Tyin Tegnestue follow in the tradition of the likes of Rural Studio, virtuously working for and with local communities, including utilising community skills during design and construction. Among their many inspirational projects I chose Soe Ker Tie House (Butterfly House) which was built in just six months and for just $11,500 USD. They exchanged skills, techniques and knowledge with the local community, with whom they designed and built six dormitory houses for Burmese orphanage refugee children on the Thai-Burmese border. Unlike most designers, Tyin Tegnestue were also involved in the construction process, providing a critical learning and feedback loop.

The six butterfly houses are built in timber with a raised floor, using traditional bamboo weaving techniques and locally sourced bamboo for the facades. The butterfly shaped, lightweight tin roofs allow water to be collected in the rainy season for use in the dry season. Bamboo is also utilised as 'honeycomb windows', giving security, privacy and light but also natural ventilation and solar shading. At higher level, openings with timber shutters are provided for further air breezes while providing solar shading. The result is playful, beautiful and sustainable and the product of sharing of knowledge, skills and creative forces with the local community. This is inherent of most of Tyin Tegnestue's work: they tend to work in areas of need, with the local community directly involved in the design and building, and they establish a mutual learning process. Due to the nature of projects and constraints of budget and remoteness, local materials and skills are utilised from project conception to completion. Rather than as acting as a constraint, this has helped generate a new, local vernacular architecture which is truly delightful. Like the Inuit igloos, local materials have to be used within limited budgets and time constraints. Yet the architectural results are refined and poetic, despite (or thanks to?) it being an architecture of necessity.

Of course the beauty of their work is in part due to the rethinking of traditional and local materials and the local vernacular, which demands in a hot, humid, tropical environment for air to flow freely in buildings and between spaces to provide thermal comfort. They reinvented locally available materials and techniques to do exactly that, to a stunning effect.

ABOUT THE AUTHOR

Sofie Pelsmakers is a chartered architect and environmental designer with more than a decade of hands-on experience designing, building and teaching sustainable architecture. She taught sustainability and environmental design and led a masters programme in sustainable design at the University of East London. She is currently a doctoral researcher in building energy demand reduction at the UCL Energy Institute and co-founder of Architecture for Change, a not-for-profit environmental building organisation.

She is author of The Environmental Design Pocketbook (RIBA Publishing, 2012), which synthesises her practical and academic expertise to support the building industry towards a significant change in its design and building practices. It received commendation for the RIBA's 2012 Presidents Awards for Outstanding Practice Based Research.

Scottish Borders home

mixes ecology and efficiency

A stunning location, thoughtful design and a certified passive house: a new home in the wooded hills of the Scottish Borders manages to have its cake and eat it too.

Words: Lenny Antonelli

Photos: (main):Sandy Halliday; (top right): Sight Shift Photography

In 2005, husband-and-wife Ian and Anne saw an ad in The Scotsman newspaper for a plot of felled land in the hills of the Scottish Borders. They visited the site and fell in love with what they saw: captivating light, wooded hills, seclusion, a view over the river Tweed.

By April the following year, they'd bought the site and hired leading green architects Gaia Group to design their home. The firm says its focus is building healthy, energy-efficient homes, and that it aims to avoid the use of heavily processed or polluting materials in its buildings.

Ian and Anne spent much of the next two years clearing the site of tree stumps, bracken, rosebay willow herb and stones.

Anne jumped headfirst into the design. She had a good idea what she wanted: a timber house in a clearing on the slope, but one that would settle into the site. "Kind of hidden but yet with fantastic views," she says — something that would "have the wow factor but be understated".

But she also wanted the design to incorporate stone – a timber frame house that would rise out of the stonework.

She spent almost three years fine-tuning the design with Gaia, and the team ended up with a concept similar to the one they had started with — for Ian and Anne this just reinforced the feeling that they'd got the design spot on.

But the couple were faced with a decision: what to build the house with? For many projects that Passive House Plus features, this often comes down to a choice between block construction or timber frame. But prompted by Gaia, Ian and Anne plumped for something a little different.

Conceived by the German engineer Julius Natterer in the 1970s, brettstapel is a type of glue-free massive timber construction that has become popular in central Europe.

The system is composed of softwood posts that

are connected with hardwood timber dowels. The dowels have a lower moisture content than the softwood posts, so over time the dowels soak up moisture to achieve an equilibrium, expanding and locking the posts together to create a load-bearing system. Brettstapel uses low grade timber that would otherwise be unsuitable for use in construction.

Gaia Group designed the UK's first brettstapel building in 2009 — Acharacle Primary School on Scotland's west coast. Brettstapel had been used in Ireland on Navan Credit Union, a pioneering, regulation-bending eco building completed in 2005 by Paul Leech: Gaia Ecotecture. As the name suggests the Irish practice are connected to ▶

“What I liked about the idea of a passive house was that instead of having modern ways of generating energy, it would just save energy by being well insulated.”

Gaia Group via the loose-knit association of architects Gaia International.

But Gaia Group didn't just convince the couple to build a brettstapel house, they persuaded them to build a passive one too.

"The passive house targets were simple to achieve using the brettstapel system, which was developed within a culture where high build quality is taken really seriously — unlike in the UK," says Prof. Sandy Halliday of Gaia Group.

She says that glue-free brettstapel contributes to a healthy indoor environment and locks up carbon too. But because it's not yet manufactured in the UK, it's still expensive.

"We'd never heard of passive house or anything like that," Ian says. But Anne loved the simplicity of the concept, adding: "What I liked about the idea of a passive house was that instead of having modern ways of generating energy, it would just save energy by being well insulated."

Gaia took the couple on a tour of passive and brettstapel buildings in Austria. They continued clearing the site in 2009 and 2010, and started planting native bulbs and trees to supplement the naturally regenerating birch.

Local contractor Rodger Builders laid the foundations late that summer, and in November Austrian brettstapel specialists Sohm arrived to the Scottish Borders.

But the project hit a snag: while seclusion was part of the site's appeal, getting lorries up the track to it proved tricky. When the snow arrived, one of Sohm's lorries got stuck and almost slipped into a neighbour's garden. The lorry was eventually set free, but Ian and Anne needed a new way to get the brettstapel panels to the site. Luckily the local shopkeeper stepped in, allowing the lorries to unload in his car park, from where a tractor trailer took the panels to the site.

Just six weeks later the house was up, air and water-tight, and Ian and Anne could walk around the bare rooms. The Austrian team worked throughout the snowy winter. "The Austrians were working 12 to 14 hour days, there was snow all over the place and the daytime temperature was ▶

sometimes below -15C. Nobody else was working but the Austrians just got on with it," Ian says.

The finished house is a testament to the years of design work, and the team's attention to detail. While the house is fairly big, it still manages to complement its wooded, hilly setting rather than obtrude from it. And it's seriously green too.

The walls are insulated with 340mm of Steicoflex woodfibre insulation, which is made from low-grade wood fibres that are bound together with tree resin. The internal sheathing board serves as the main airtightness layer.

"The challenge was simply ensuring that once we had the primary structure tested and passed that we did not undermine it during the fit out phase," Gaia's Sandy Halliday says of meeting passive house airtightness standards.

The roof, which is topped with soil and planted with native wildflowers, was also constructed with brettstapel and insulated with 360mm Steico woodfibre. The ground floor features 260mm of Steico above the concrete slab too.

Continuing the devotion to timber, the windows are triple-glazed, timber aluclad units, built and fitted by Austrian manufacturer Bohler Fenster.

And there's really not much else to it. This is a project that epitomises the simplicity that is at the heart of the passive house standard: build a high-quality envelope, orientate properly, make it airtight and insulate it well.

A heat recovery ventilation system extracts stale air and pre-heats cool, incoming fresh air. If Ian and Anne need it, they can turn on a small 1.6kW electrical heating element in the ventilation ▶

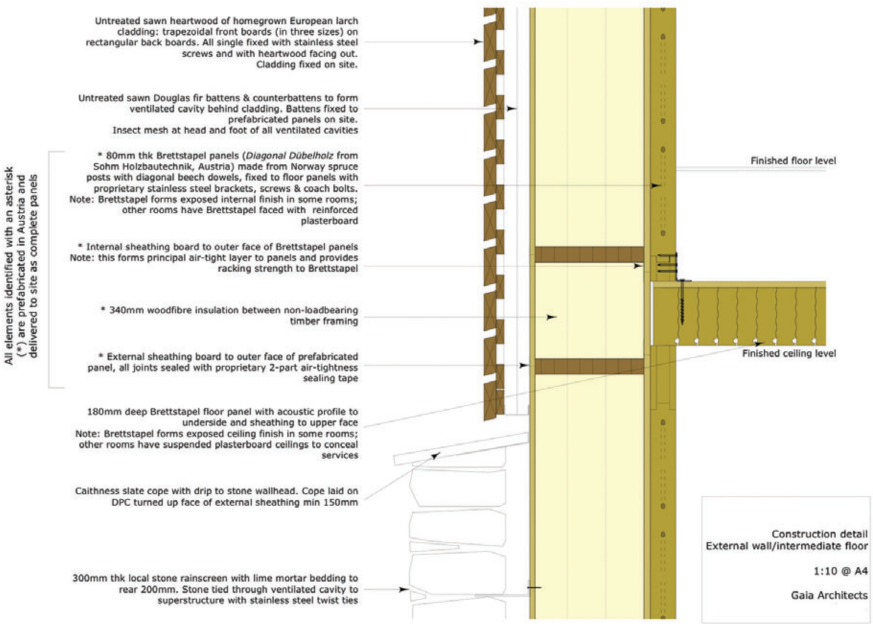
system to boost the temperature of incoming air.

They also have a wood burning stove in the lounge, but find the house gets too hot if they use it. "The stove is more for comfort and effect," Ian says. A small solar thermal array helps to provide them with hot water too.

Overheating is more likely to be a problem than cold. To combat this, there's a brise soleil over the big south-facing window in the atrium, plus balconies that overhang windows in the kitchen and south-west bedroom, and external blinds for the lounge and south east bedroom. The couple say the summer of 2012 wasn't much of a test for overheating, but they survived comfortably.

Gaia are carrying out a two year evaluation of the house's energy performance. But the awards are already rolling in. In June 2012 the house won the Scottish Home Award for Architectural Excellence. Not long after it was certified by the Passive House Institute — the plaque to prove it now hangs just outside the front door.

SELECTED PROJECT DETAILS
Architects: Gaia Architects
Contractor: Rodgers Builders
brettstapel system: Sohm Holzbautechnik
Structural engineer: Harley Haddow
Quantity surveyors: Ralph Ogg & Partners
Green roof: IKO
Grass seeding: Var Scotia
Windows and doors: Bohler Fenster
Roofing: AIM Developments
M&E engineer: Mott McDonald Fulcrum
Solar thermal: Baxi
Consulting engineer: Sohm Holzbautechnik
Cladding contractor: Abbey Timber
Flooring: Solus Ceramics
Lighting consultants: Mott McDonald Fulcrum
Insulation: Steicotherm
Heat recovery ventilation: Sustainable Homes Scotland
Internal woodwork: Real Wood Studios
Stonework: Grant Morrison Stonecraft



PROJECT OVERVIEW:

Building type: 297 square metre detached passive house that occupies a previously wooded area on a steep east-facing slope. Constructed from brettstapel, a glue-free form of massive timber construction.

Location: Scottish Borders

Completion date: 2011

Budget: not disclosed

Passive house certification: certified

Space heating demand (PHPP): 14 kWh/m²yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 109 kWh/m²/yr

Airtightness (at 50 Pascals): 0.5 air changes per hour

Energy performance certificate (EPC): B (81) — the architects told Passive House Plus that they have identified errors with the EPC that render it incorrect.

Ground floor: 40mm slate finish, followed underneath by 13mm Fermacell, 18mm timber sarking board, 120m Steicoflex woodfibre insulation, 140mm Steicoflex woodfibre insulation, vapour barrier, 150mm reinforced concrete slab. U-value: 0.145 W/m²K

Walls: Timber cladding (rainscreen) on battens externally, followed inside by timber sheathing board, 340mm Steicoflex woodfibre insulation, another timber sheathing board, 80mm diagonal Dubelholz brettstapel panel. U-value: 0.12 W/m²K

Roof: 80mm top soil externally, followed underneath by 360mm Steico Isorel plus insulation, bituminous layer, 19mm plywood, 55mm angled Steicotherm woodfibre insulation, 180mm diagonal Dubelholz brettstapel panel. U-value: 0.08 W/m²K

Windows: Bohler Fenster boe_classic + timber aluclad triple-glazed windows with Chromatec Plus spacers. Frame U-value: 0.86 W/²K. Glazing U-value: 0.6 W/m²K.

Heating system: 1.6 kW electric heating element in HRV system. Cylinder with 6 kW electric immersion element as well as a coil from the two evacuated tube solar water heating panels situated on the roof (5.6 square metres), producing approximately 2 MWh per year.

Ventilation: Paul Novus 300 mechanical heat recovery ventilation system.

Other green features: The previously monocultural forest environment has been extensively re-planted throughout along with a pond and a sedum roof has allowed the reintroduction of native plant species, to enhance the biodiversity of the site. The bird and animal life is now significantly more diverse than was the case on the mono-cultural site that the house and gardens replaced. External cladding, fittings, furniture and many other elements have been built from materials local to the house.

(above) a custom-made brettstapel panel being manufactured in the Sohm Holzbautechk factory in Austria; a construction detail reveals an elegantly simple build approach

Sustainability with a passive

One of the UK's first nondomestic buildings to gain passive house certification, the Simmonds Mills designed Green Base centre is an embodiment of the environmental ethos it seeks to promote.

Words: John Hearne & Jeff Colley

A central factor in the success of the Green Base project in St Helens, Merseyside was the fact that the client bought into the passive house idea at a very early stage.

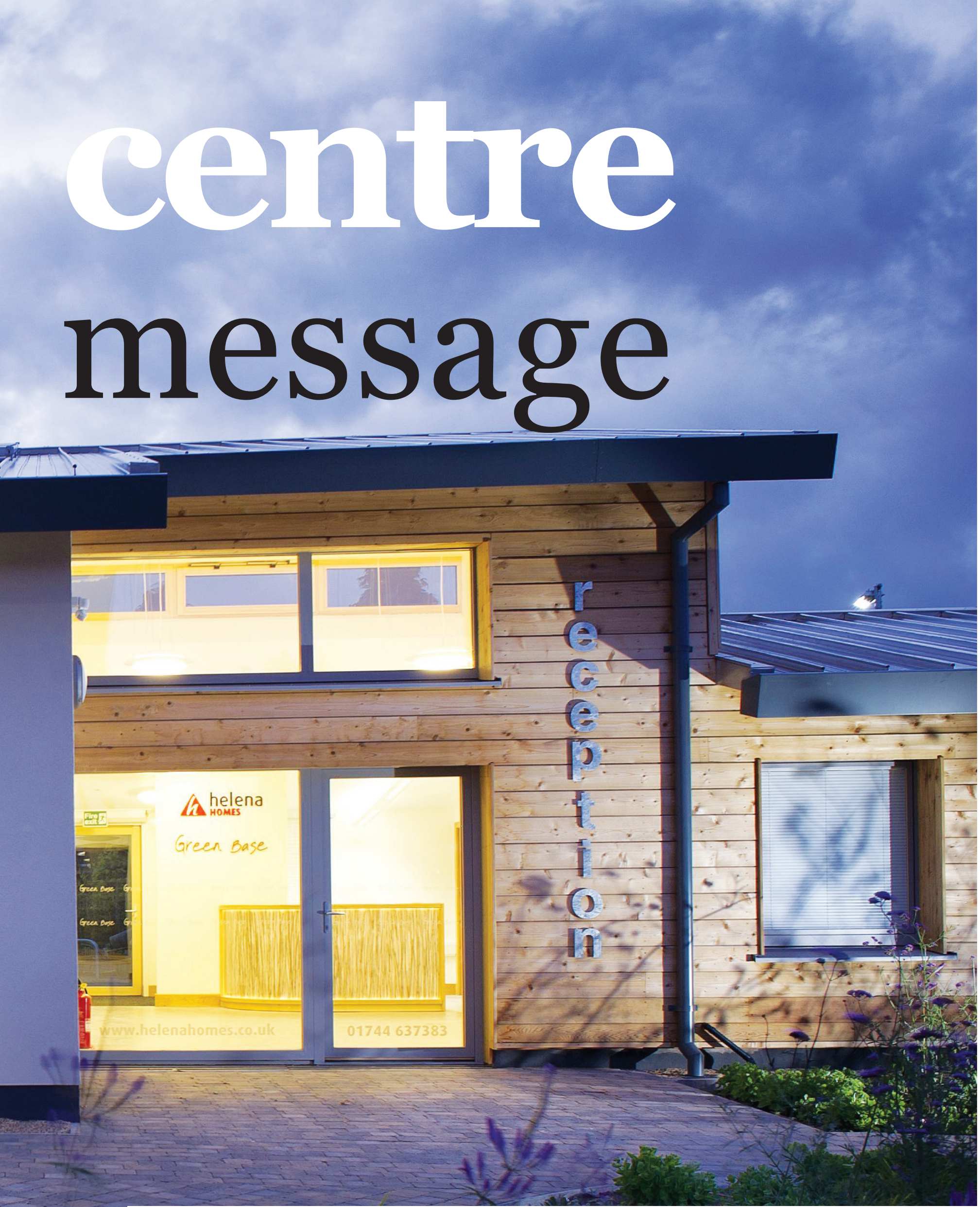
Simmonds Mills Architects tendered for the job just after they had completed the Centre for Disability Studies, a building in Essex that achieved passive house certification. During the selection process in Merseyside, the architect brought the client down to the centre to view the passive house approach in action.

Explaining passive principles while actually in a passive building makes that message so much more powerful. "They immediately saw those high levels of daylighting," says architect Andy Simmonds. "They saw the sunny spaces. They sensed the air quality and then the thermal comfort."

Simmonds – the current CEO of the UK sustainable building association the AECB and co-founder of the Passivhaus Trust – also gave a presentation on his own home, Grove Cottage, the first building in the UK to be certified to the Passive House Institute's retrofit standard, Enerphit. "The clients really liked the presentation as it was relevant to a new building in the middle of a housing estate," he says. Given that the same energy saving principles apply to passive house and Enerphit projects, the client was taken with the idea that it's new nondomestic building might point to what's possible with a retrofit.

The client, Helena Homes, is a housing association and registered charity. Liz Ackerley of the association explains the need for a new building arose when it was decided to bring the organisation's landscape maintenance services in house, with the aim of promoting

centre message



Photos: Alan Clarke

horticulture and sustainability in the local community. At their 13,000 household Queensland Estate in Thatto Heath, the company set out to create a building that would harness this ambition.

The site chosen was in an area which Ackerley terms ‘backlands’ – a landlocked site surrounded by houses which had become a dumping ground. The idea was to transform the site into community gardens, where various horticultural projects could be showcased. The building at its centre would provide office accommodation for Helena Homes’ Green Space Service, and an information centre for the local community.

“We wanted to link into the green agenda in the context of the building itself,” says Ackerley. “What we didn’t want was a bells and whistles approach where we had a bit of this and a bit of that and a bit of the other. We didn’t want a high-tech building, but one which would demonstrate sustainable principles, something that wouldn’t guzzle a lot of energy. Passive house was the obvious choice.”

The focus wasn’t simply on energy conservation. The building also had to address the landscape in which it sat in a way which reflected the broader aims of the project.

“They wanted us to come up with a way that a building might fit in and integrate with Helena’s imaginative edible landscape concepts,” says Andy Simmonds. “We were asked to propose ideas about how the building created a variety of external spaces with different orientations, so we paid close attention to the way the building and pedestrian movement on site related to the street, the more private areas and the existing pathways through the backlands – suggesting these should be ‘green’ corridors.”

Passive building principles always favour tight, non-dispersed footprints simply because they’re easier to heat, but meeting the needs of the Green Space Service called for a building that wasn’t that straight-forward. In addition to ensuring that the building addressed the external landscape in a particular way, the design team also had to allow for the possibility of extensions in the future.

Passive house specialist M&E consultant Alan Clarke explains that at this stage the design process became a circular one. The architects came up with a concept, Clarke modelled it on the passive house software PHPP, and if it wasn’t hitting the targets he reverted with suggestions about how it might be changed.

“In this case, with a single-storey small building, it was a case of first of all seeing what we could do about reducing the external area,” says Clarke. “We used PHPP to work out the external area to floor area ratios.” He adds that though the initial model included the same U-values as the Essex project, a combination of fenestration, overall size and climate data kept putting it just out of range of passive targets.

Andy Simmonds says that at this stage, there’s frequently a ‘nervous dynamic’ within the design team. You want to make maximum use of the leeway passive house gives you, but you don’t want to jeopardise certification by straying over those strict limits.

“You can’t guarantee that your M&E person is going to do PHPP in exactly the same way as the actual PH certifier,” he says, “so we spoke to the certifier and the general advice is just make sure you’re well in. Make sure you’re well in below that 15 KWh/m²/yr.”

Once it hit construction phase, the project became detail-oriented. At the time, Simmonds was refurbishing his own home to the Enerphit standard. Building on the experience gained here and during the Essex job, the design team were able to re-use tried and tested details to address thermal bridging and airtightness issues.

A shipping error resulted in shallower I-beams being delivered to site than the intended depth of 450mm. In order to keep to schedule and retain the right U-values, the design team found a solution in specifying a high performance foam instead of the mineral fibre that had originally been envisaged. “This caused consternation in our office because the foam had very high global warming potential,” says Simmonds. “We’ve always tried to avoid chemically complex insulants where we don’t need to. ▶

(above) different external insulation strategies were chosen for the building's timber clad and rendered sections; (below) the reception area with desk featuring recycled materials and expressed ventilation ductwork; (p43, top) the raft foundation is insulated with 250mm EPS; (bottom) the external insulation system being applied, including 250mm of platinum EPS

And we were very reluctant to be a practice that now suddenly had to start using them."

But because the alternative would have involved disposing with the shallower I-beams – which were custom manufactured for the lengths and shapes needed for Green Base – arguably the foam became the most environmentally friendly fix. Several of the details now had to be reworked to ensure that airtightness targets were met without introducing thermal bridges. To avoid too many different insulation installers on site the decision was made to insulate the Larsen truss walls – which were previously specified with Perimeter Plus insulation too – with the foam as well as the roof structure.

Airtightness was achieved primarily through what Simmonds describes as 'robust' methods: a combination of internal plastering, tapes and mechanically clamped airtightness membranes, together with the aforementioned PU foam in the ceiling. Some issues arose when cabling was accidentally rerouted through the wrong area, but remedial action prevented it from compromising the passive house standard's air change target.

Though main contactor Paragon Construction had previously built to levels four and five of the UK's Code for Sustainable Homes, Green Base was the company's first passive house project. "It was quite untracked territory for an English contractor," says Paragon MD Paul Barrow. "Because it's a partnered scheme with a local housing association it allowed the contracts to be conducted in a very hands on way with a collective buy in from the client, the architects and ourselves."

Barrow says that in some regards the build "was pretty in keeping with the type of stuff we do – Grand Design type properties. The in-house build team we have are used to working to high quality levels."

The build process itself was fairly straightforward, though Barrow stresses that heavy emphasis was placed on maintaining the airtightness throughout the scheme. Paragon's mechanical and electrical subdivisions installed the building services, enabling tighter control to ensure the trades paid attention to the airtight layer. "It just lent itself well to a passive house level of build, given the emphasis that's required on airtightness," says Barrow. "Before we even set foot on site we had numerous workshops to educate our site team about what passive house meant, what it would entail and to get full buy in from everyone. That

really paid dividends on site." A first airtightness test before the walls were plastered internally came in at 1 air change per hour. "We made sure before we plastered that all the junctions were taped to be absolutely airtight," he says. A second test after plastering gave a result of 0.44 ACH.

Citing former UK Energy Secretary Chris Huhne's speech at the 2010 UK Passivhaus Conference, Barrow says that Paragon see a future in passive house. "It's how things should be done in terms of sustainable build quality," he says, adding that the company has developed designs for passive house within budgets for affordable housing schemes. "We're actively trying to get clients to consider passive house, whether it's housing, commercial or anything else for that matter."

Space and water heating is provided via a conventional combi gas boiler, together with conventional radiators. "You give that to a plumber," says Alan Clarke, "and he'll know what to do."

Solar thermal water heating was considered, but given the fact that office buildings have low hot water requirements, it was decided that it wouldn't be an appropriate investment. Ventilation comes via two separate Paul MVHR units. Again, simplicity was the watchword. Clarke explains that two separate systems were chosen to avoid any customised control design.

"We steered very strongly away from air heating partly because we see the ventilation as running during the day time when loads are high. On the other hand, from Friday to Monday, while you may still need to put heat into the building, you only need a tick over of ventilation."

In its first year of occupancy, measured energy usage is actually coming in below forecast values. Liz Ackerley says that while the building is simply working well, the occupants are highly motivated and tend to watch their energy use.

"We have a number of other buildings in the association. At our head office, you're either too hot or too cold. That doesn't tend to happen here. You don't get draughts and the air is really high quality. We have hot desks here, and we're finding a lot of people tend to come here to use them. The whole space has quite a calm sort of atmosphere."

SELECTED PROJECT DETAILS
Clients: Helena Partnerships
Architects: Simmonds Mills architects
Contractor: Paragon Construction Group Ltd.
Quantity surveyors:
Client in-house team in partnering contract.
Civil / structural engineer:
Bob Johnson Structural Engineer
Services consultants: Alan Clarke
Airtightness tester: Technology Centre
Windows & doors:
Internorm Varion, supplied by Frames Direct Ltd.
Airtightness products: Klober
Insulation:
Wetherby render system & Jablite & Walltite
Plasterboards : Fermacell
Organic paints: Osmo
Heat recovery ventilation: Green Building Store

PROJECT OVERVIEW:

Building type: 212 sq m detached single-storey non domestic building, raft foundation and blockwork walls with external insulation.

Location: St Helens, North West England

Completion date: October 2011

Budget: £522,000 overall project costs, including landscape and services.

Passive house certification: certified

Space heating demand (PHPP): 15 $kWh/m^2/yr$

Heat load (PHPP): 12 W/m^2

Primary energy demand (PHPP): 117 $kWh/m^2/yr$

Airtightness (at 50 Pascals): 0.44 ACH

Measured energy consumption: (Oct 2011 – Oct2012) Natural gas for heating and hot water: 21 $kWh/m^2/yr$. Electricity import: 24 $kWh/m^2/yr$, PV generation: 24 $kWh/m^2/yr$. On-site electrical consumption estimated at 32 $kWh/m^2/yr$)

Thermal bridging: thermal bridge free details, based on AECB CarbonLite guidance.

Ground floor: Raft foundation insulated with 200 mm Jabfloor EPS, U-value: 0.175 W/m^2K (PHPP calculation), 0.13 W/m^2K (SAP calculation. All below U-values are based on PHPP calculation)

Rendered walls: Wetherby render system, on 250mm platinum EPS insulation, on 140mm dense concrete block, with internal plaster finish: U-value 0.125 W/m^2K

Timber clad walls: Horizontal douglas fir timber cladding, on Klober breather membrane, on OSB, timber site-made Larsen trusses with 350mm full-fill blown PU foam insulation, on 140mm dense concrete block, with plaster internal finish : U-value 0.085 W/m^2K

Roof: Aluminium profiled roof finish, Klober breather membrane, OSB, 300mm timber I-beams with 50mm counterbattens, giving 350mm full-fill blown PU foam, 15mm Fermacell & skim : U-value 0.085 W/m^2K

Windows: Internorm Varion windows and doors; triple and 2 + 1 glazing; overall average U-value of 0.94 W/m^2K

Heating system: Broag Rehema Avanta 28 ECO 6-28kW condensing gas combi boiler (SEDBUK SAP2009 efficiency 89.1%) with room compensated control, ordinary radiators. Hot water distribution via small bore radial pipework to minimise draw-off volumes.

Ventilation: Two Paul Novus 300 heat recovery ventilation units — Passive House Institute certified to have heat recovery rate of 93%. One unit serves general offices and ancillary space, other serves meeting room only.

Electricity: Solar photovoltaic array on south facing roof with monitored output of 24 $kWh/m^2/yr$

Green materials: Low VOC Osmo wood paint and stains. Reception desk made from recycled & natural materials. Low water usage sanitaryware. FSC accredited timber generally and cladding timber sourced from UK woodland.

IRELAND'S most energy efficient

A new house in Wexford is the first in the country to achieve an A1 Building Energy Rating and certified passive house status – arguably making it the most energy efficient building yet built in Ireland. So why did a regulatory flaw risk rendering it non-compliant?

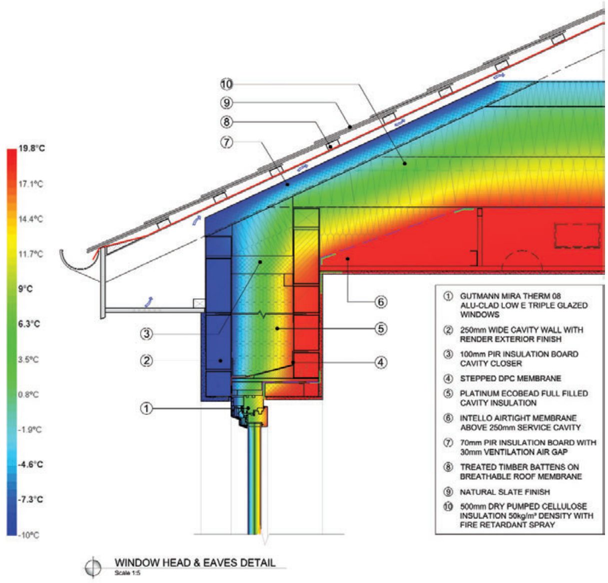
Words: John Hearne & Jeff Colley

Francis and Brigid Clauson's new self-build is arguably the most energy efficient house yet built in Ireland. Yet it almost failed to meet building regulations. When working through the calculations for his Building Energy Rating (BER) Clauson discovered that though his plan would comfortably meet the highly onerous passive house targets, it would actually breach the renewable energy obligation under Part L of the building regulations.

Long before he broke ground on his elevated site in Bunclody, Co Wexford, Clauson carried out an enormous amount of research. In addition to many hours on the internet, he talked to dozens of professionals and went to visit houses and sites to question people about the choices that they had made. "I'm absolutely maniacal on detail," he admits. "I questioned every single individual extensively about what they were telling to fully validate their responses."

An IT professional by trade, Clauson and the design team he chose used two software packages to design and model the energy performance of the building. Deap – the Dwelling Energy Assessment Procedure – is the Irish equivalent of the UK's Sap software, and is used to calculate Building Energy Ratings and demonstrate compliance with energy efficiency targets under Irish building regulations. PHPP is the software developed by the Passive House Institute for the design of passive houses. In order to fully understand both, Clauson actually built a model which married them together. It was while working through the figures on his hybrid model that he turned up this startling anomaly: his house was so energy efficient he couldn't generate enough renewable energy to meet minimum requirements set by the Department of the Environment. The house just didn't have the energy demand. "If you need 50 to 75 kWh/m^2/yr – as an A3 house would – then it's easy to generate 10Kwh/m^2/yr of renewable energy," he said. "But as you reduce this demand to say 30 kWh/m^2/yr the percentage of overall energy which has to come from renewables grows – and thus becomes harder to achieve."

The problem stems from the changes to Part L of the Irish building regulations introduced in 2007, when renewable energy systems be-



Photos: Paul Tierney

building?

came mandatory for all new homes, along with unprecedented improvements in terms of both energy efficiency and carbon emissions. The regulation itself doesn't go into detail. Instead it makes some general statements about energy efficiency, carbon emissions and renewable energy. It states that new homes must be designed and built "to limit the calculated primary energy consumption and related carbon dioxide emissions insofar as is reasonably practicable". It then adds the requirements that a "reasonable proportion" of that energy demand must come from renewable sources. There's a subtle but important point in this cumbersome language. The regulation says that energy demand and carbon emissions must be reduced to the greatest extent possible without going to unreasonable lengths, but it doesn't go so far with renewables – it only requires that renewable energy makes up a reasonable fraction of the total energy demand.

These general statements are fleshed out into clear targets in the technical guidance documents (TGDs). When the new Part L was published in 2007, TGD L was also updated. It defined the energy and carbon saving targets as 40% reductions in primary energy for space heating, hot water, cooling and lighting, rising to 60% reductions in changes to TGD L from December 2011. But both changes to TGD L set the renewables target at a fixed number – 10 kWh/m^2/yr of thermal renewable energy, or 4 kWh/m^2/yr of microgenerated electricity. This wasn't a widespread problem for people building to scrape compliance with TGD L 2007, as for most building types the 40% energy reduction target still left a reasonable chunk of primary energy, meaning renewables still had a demand to help meet. For some smaller house types a fairly small solar thermal array could hit the 10 kWh/m^2/yr target. Biomass boilers could typically comply, as could many heat pumps in spite of being penalized for various reasons outlined below.

According to the Department of the Environment, meeting the targets set out in TGD L indicates "prima facie" evidence of compliance – a legal term which means that building to the levels set out in the TGD ensures compliance with the regulation. The department is on record as saying that the only way to actually guarantee compliance is to hit the targets stated in the TGD. When pressed on this point by Passive House Plus editor Jeff Colley at the See the Light conference in Dublin in September last year, a department spokesman said that people who've built very low energy homes and therefore failed to meet the renewables target would need to take their cases to court if they're to prove compliance.

Clauson had determined that the most pragmatic way of heating his super low energy house was by using a heat pump. The problem however is that the house is so well insulated, so airtight and so cold-bridge free that very little heat is actually needed. Clauson's solution was to choose a heat pump capable of being ▶

“The construction details and solutions are familiar to a lot of Irish tradesmen.”

programmed to match the building’s actual heat loss on a live basis: a Danfoss air to water heat pump installed by Heat Doc Ltd. “For super low energy houses that ability to auto adapt and adjust minute by minute is key to maintaining comfort levels,” says Mike Teahan of Danfoss distributors Heat Pumps Ireland. “Most modern heat pumps have this built in functionality.”

(above left) airtightness detailing was a painstaking, iterative process to make sure it was done right; (above right) the house was built using standard blocks, with a 250mm cavity which was pump-filled with bonded bead cavity insulation; (below) client Francis Clauson on-site during the build;

(opposite, clockwise from top left) a room sealed wood burning stove can supply heat in the living room if required; thermal bridges at foundation were dealt with by using Quinn Lite blocks in the rising walls; an airtight and thermal bridge free wide cavity window sill detail

But both Deap and the new regulations give heat pumps a hard time. TGD L stipulates that only energy above a seasonal performance factor (SPF) of 2.5 can be counted towards the 10 kWh target to take account of the primary energy of grid electricity due to generation and transmission losses. According to Deap, every kilowatt used by the heat pump takes 2.42 kilowatts of energy use at the power station – 10% lower than the 2.7 kilowatts Deap listed till 2011.

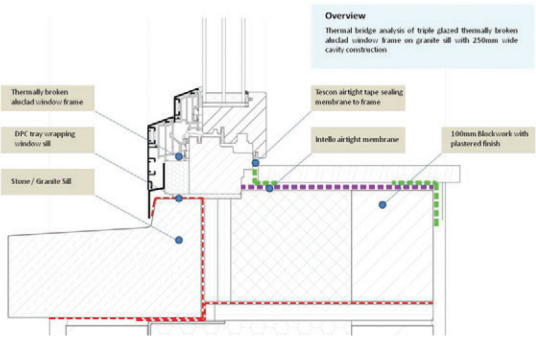
Energy from the heat pump to provide hot water can be counted towards the 10 kWh target, though this portion of the heat pump’s output is subject to a 25% penalty to take account of efficiency losses at higher temperatures.

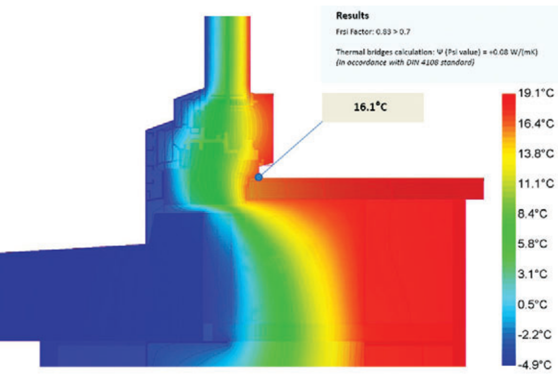
But other penalties are due to the software’s difficulties handling non-traditional heating approaches. Deap assumes intermittent heating – where the building first goes cold and is then quickly loaded with high temperature heat. “The problem is that Deap is treating your heat pump as if it’s a boiler,” Mike Teahan explains, adding that the problem would have been exacerbated if Clauson had paired the heat pump with radiators. “When you plug a heat pump running on rads into Deap it automatically assumes you have an on/off cycle of heating up and cooling down. If you heat a building in this way you’ll have to use the heat pump at high temperature to bring the building back to the desired temperature quickly. But if you use a

heat pump with rads, full weather compensation, and minute-by-minute control, you don't have to have the rads at high temperatures. The temperature of the rads changes subtly as the weather changes."

Teahan has a word of caution regarding how many people think the renewables obligation works. "Most people seem to think that if you work out the size of the house times 10 kWh, that's what you need to provide from renewables. That's not the case at all. What you're actually required to do is bring the BER result of the house down by 10 kWh/m²/yr."

Clauson worked out in Deap that his heat pump would provide just 5.21 kWh/m²/yr towards the renewables obligation whereas his total energy demand is 42.64 kWh/m²/yr, so the proportion of energy provided by renewable technologies needed to be 23%. The big question is, does this 23% represent a 'reasonable proportion'? What if Francis Clauson decides that it does but the building control officer decides that it doesn't?





Once he'd discovered this flaw, he went on to conduct a series of experiments on Deap. He reduced his thermal bridging values back to default figures, thereby seriously compromising the integrity of the building envelope. The exercise pushed the heat pump's contribution to the energy needs of the house up to 9.3 kWh/m²/yr. Still not enough. Then he reduced the air tightness from the passive standard target of 0.6 air changes per hour to the default 7 m³/hr/m², and this finally pushed his renewables contribution above the TGD L threshold, to 15 kWh/m²/yr.

Though these changes moved the renewables contribution from 5.21Kwh/m²yr to 15 Kwh/m²/yr, they made the building less energy efficient. "This is barmy," says Clauson.

The other alternative – and the one Clauson chose – was to add additional renewable technologies to his house, in this case a solar photovoltaic array. "If I threw away my window certificate and threw away my heat recovery certificate and just reverted to default values, I wouldn't have needed to put the PV panels on the roof," he says. "You could say that my PV is eco-bling but I had to put it in place to comply with the regulations. But that said, at Christmas it enabled me to cook my turkey and ham for nothing!"

Ironically, Clauson's original intention hadn't involved passive house, or even low energy. "The whole point of the house was really to capture the sun throughout the day, but as we got further through the process, we realised that the difference between part L of the 2011 regs and passive is insignificant. That's when we decided to go for it."

He engaged architect Zeno Winkens and Archie O'Donnell of Integrated Energy as energy consultant, and got a local contractor, Chris Gahan of GR8 Construction to do the work.

Zeno Winkens says that at the outset, Clauson provided him with a sketch together with a highly detailed brief – "nearly down to the hooks on the back of the door in the children's bedroom…" Taking this brief as a wish list, Winkens carefully assessed the site and came up with a design that married the client's needs with passive principles. "The site wasn't 100% north south, it was coming in at an angle, that's why I chose the L design with a cut-off corner," he says. "Though it's quite a large house, from the road, it still manages to look quite modest."

With design, orientation and layout agreed, the design team moved on to how the house might be built. "I followed the mantra of the four Ps," Clauson explains. "Passive, pragmatic, price-conscious and practical. Any measure we took had to hone into those four."

He investigated both timber frame and externally insulated options but elected in the end to go with a conventional building method – a standard block built wall, albeit with a wide, 250mm cavity. The robustness of the block was a big attraction for Clauson, plus the way it dealt with the Irish climate on what would be a very exposed site. The fact that it is such a long established construction method and that there was extensive local expertise was also a deciding factor. "What's critical about this project is that it's been built by local trade using local materials," says Archie O'Donnell of Integrated Energy. "When we started doing passive house a lot of the techniques and technologies would have been copied from central Europe and I think what's useful about this is that the construction details and the solutions are ones that are familiar to a lot of ▸


BBA
APPROVED
CERTIFICATION

Irish tradesmen."

Chris Gahan of GR8 Construction says that the exhaustive research and huge level of preplanning that Clauson put into the project was central to it success. "Francis had weekly or fortnightly meetings, complete with agendas, so it was run more like a commercial job than a one-off house," he says. "To get to passive, you have to be detail oriented, we all knew that starting out. To be honest it ran very well."

Thermal bridging issues at foundation level were dealt with through the use of Quinn Lite blocks in the rising walls. Thereafter, designing away cold bridges and ensuring airtightness with a wide cavity construction involved the drafting of more than twenty individual details in a painstaking, iterative process. "Each detail was investigated by the design team," says O'Donnell. "They would have been improved, they would have been put through thermal analysis, further improvements would be made, then we'd coordinate with say a plumber or an electrician and improve those details yet again."

Installing the windows did present particular problems. Alan Tier of Integrated Energy explains that their initial aim – for aesthetic and budgetary reasons – was to install non-thermally broken 'lift and slide' windows as opposed to passive certified, thermally broken 'tilt and slide' windows. It is, he explains, theoretically possible to install non-passive standard windows and still achieve a passive standard performance, so long as no point of the internal screen is allowed to fall below 13 degrees. Tier modeled the windows exhaustively with this aim in mind, but in the end, he had to concede that due to the surface area of the building, it just wasn't possible. Instead, a combination of both passive and non passive certified windows were installed.

"Probably the biggest challenge was getting the airtightness membrane around the reveals and getting that to interface with the internal leaf of block work," says Chris Gahan.

Aided by the day lighting benefits that tend to come with passive houses – an orientation and form which tracks the sun will also yield a natural light benefit – the house's electrical lighting requirement balances energy saving with atmosphere. "The brief from the client was for the lighting design not to be dictated purely by energy efficiency," says lighting designer Rocky Wall of Wink Lighting, "but to create atmosphere and mood using energy efficient light sources." The design mixes CFLs, LEDs, IRCs and fluorescent bulbs to find the right tones of light for the house's various spaces. The control system is simplicity itself: conventional switching and dimming.

Coming up with a mechanical package for the house was another painstaking process during which various combinations of technologies were modeled and tested – from oil, gas and solar thermal through to the combination of heat pump and PV panels on which Clauson eventually settled. Speaking to Passive House Plus just two weeks after moving in, he says that so far, the house has performed exactly as modeled on paper.

"Every nut, every bolt, every screw was thought out and put down on paper beforehand," says Archie O'Donnell. "That meant that it was a dream to go on site. If there was one guiding principle that Francis brought to the project, it was that if you don't have everything thought out on paper beforehand, you're on a hiding to nothing. Nothing was left to chance, and there was no ambiguity about what was required."

For more information on this build visit the website set up by Francis Clauson: www.low-energy-construction.com

SELECTED PROJECT DETAILS
Owners: Francis & Brigid Clauson
Architect: Zeno Winkens
Energy consultant: Integrated Energy
Main contractor: GR8 Construction
Quantity surveyors: Patrick Breen
Structural engineer: Deane Turner
Heating engineer: Heat Doc Ltd
Airtightness & cellulose installer: Cliomahouse
Airtightness tester: Greenbuild
Lighting design: Wink Lighting
BER assessor: 2eva.ie
Passive house certification: Peter Warm
Airtightness system & cellulose insulation: Ecological Building Systems
Airtight plaster: Gyproc
Windows & doors: True Windows
Insulation: Isover/Kingspan/Xtratherm
Cavity insulation installer: Bunclody Insulations
Thermal breaks: Quinn Lite
Heat pump: Heat Pumps Ireland
Heat recovery ventilation: Versatile
Kitchens: Andrew Ryan
Interiors: Doyle Design

PROJECT OVERVIEW:

Building type: 359 sq m bungalow built to take in the panoramic views stretching to over 30 miles and to maximise the solar gain.

Location: Bunclody, Co Wexford

Completion date: December 2012

Budget: not disclosed

Passive house certification: certified

Space heating demand (PHPP): 13 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Airtightness: 0.54 ACH at 50 Pa

Energy performance coefficient (EPC): 0.099
Carbon performance coefficient (CPC): 0.091
BER: A1 (14 kWh/m²/yr)

Thermal bridging: great attention to detail throughout the build including first three courses of Quinn Lite blocks on all rising wall to reduce heat loss to the ground, very detailed window and door installation detail with PIR insulated reveals, thermally broken windows, sloping roof to wall join to ensure continuous thermal envelope

Airtight layer: Gyproc Airtite Quiet plaster applied to inner leaf block work. Pro Clima system including Intello membrane to ceiling and tapes at all junctions and penetrations throughout. Ceiling fixed to metal furring inside airtight layer to avoid breaching airtight membrane

Ground floor: standard sub floor construction with 200mm Kingspan insulation under screed. U-value: 0.098 W/m²K

Walls: 100mm regular block, 250mm wide fully filled with Ecobead platinum bonded bead pumped cavity insulation and 100mm regular block. U-value: 0.15 W/m²K

Roof: Plaster board / 250mm service cavity / airtight membrane / 500mm pumped cellulose U-value: 0.084 W/m²K

Windows: triple-glazed Passive House Institute certified Miratherm windows – with a typical U-value of 0.8 W/m²K

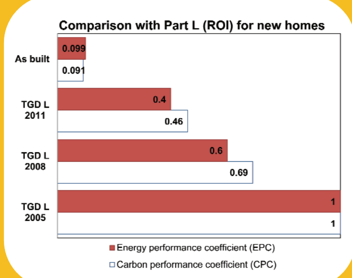
Heating system: Danfoss air to water heat pump with Harp registered SPF of 4.13. Under floor heating system across the whole building which has been left open circuit (i.e. no thermostats) except for the bedrooms which are kept cooler. Wood burning stove in sitting room

Lighting: a mix of low energy lighting including CFLs, LEDs & IRCs with dimmers and fluorescent bulbs

Ventilation: Passive Institute certified Zehnder Comfoair 350

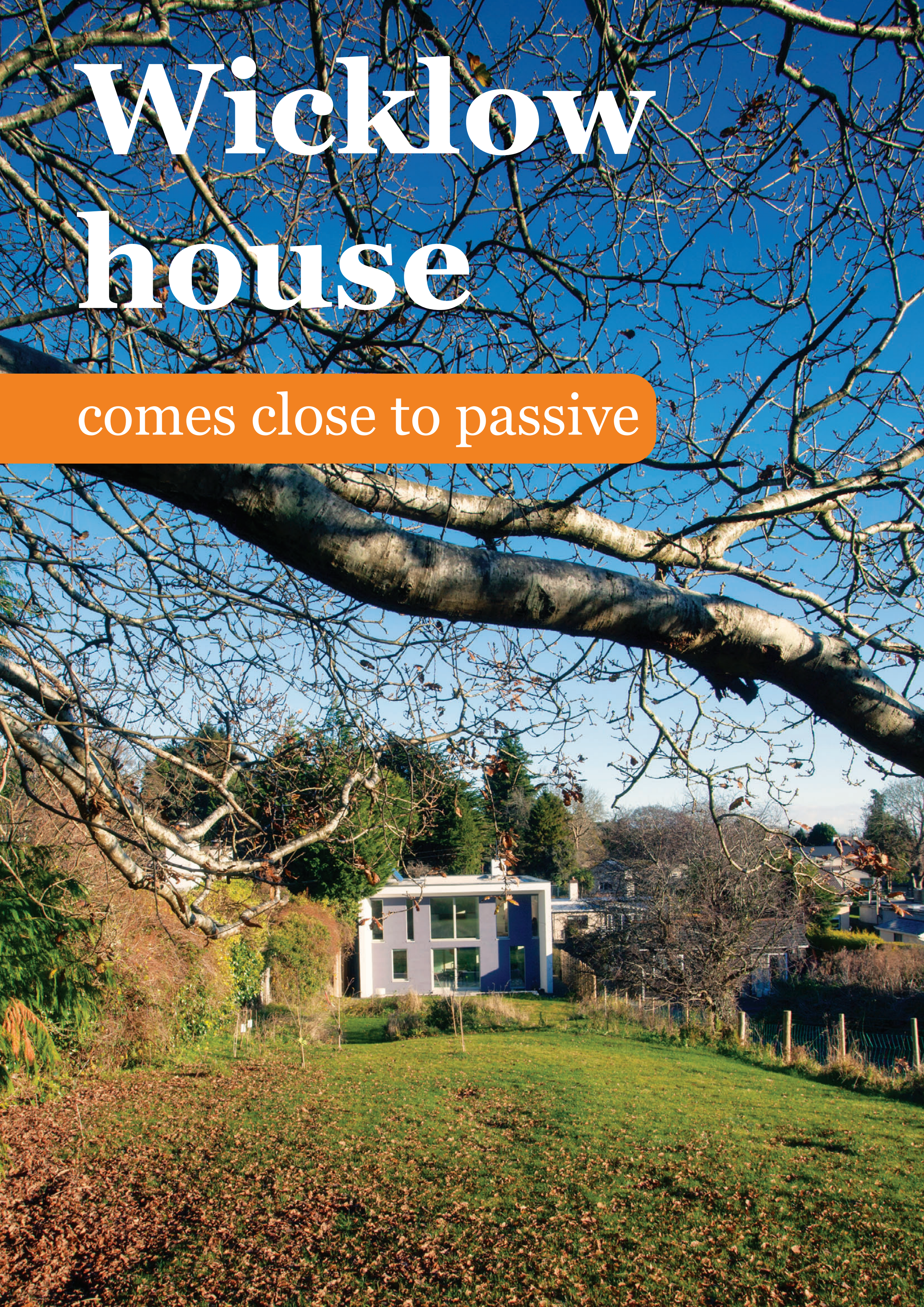
Renewable Electricity: 16m² solar photovoltaic array with average annual output of 4.2kW

Green materials: cellulose insulation, all timber furniture from PEFC certified sources



Wicklow house

comes close to passive



Photos: bNEW Photography

With a target as exacting as the passive house standard, circumstances can conspire against meeting every criteria. Architect **Sam Mays** describes a Co Wicklow home that hit every passive target except one when the builder went bust.

Every project has a story to be told about it. This one is longer and more tortuous than most.

Our clients, Simon Kennedy and Jenny Howe, had bought a site just south of Glen of the Downs in Co Wicklow, a long narrow plot of land occupied by a small bungalow. It was assumed that any replacement house would also have to be single-storey and we agreed a design that duly received planning permission. My mind wasn't quite at rest, though. I came up with a proposal for a two-storey house that I felt was a much better – and far more efficient – design and suggested we make a fresh planning application. Simon and Jenny agreed and the two-storey house in turn received permission.

The excellent envelope/volume ratio of the compact two-storey scheme meant that it became possible to consider making it a passive house. Having just completed a certified passive house in the Dublin mountains nearby (featured in Construct Ireland August/September 2011) we were familiar with the issues involved and we developed, detailed and specified the project accordingly. The design lent itself to timber frame construction and we put the project out to tender to four teams of contractors and frame manufacturers. The winning contractor – renowned amongst architects for the quality of his work – made his frame in-house and was thus able to offer a one-stop-shop service that seemed very attractive. His panels were fully finished in the workshop, complete with windows, wiring and internal and external linings, so they arrived on site ready for assembly; or at least, that was the idea…

The first problem was weather. Erection of the shell was half-complete when what turned out to be the long cold winter of 2010 set in, rendering work nigh-on impossible for several months. Construction resumed in the spring, the shell was completed and for a short period everything went well. However, progress slowed to a crawl, eventually a standstill, and it became clear that the builder was in deep financial trouble. He finally went into liquidation in November 2011. This was the nightmare scenario; we were left with a project about 85 to 90% complete and many months behind schedule. We decided to finish it ourselves, trying to keep the trades and subcontractors who had already worked on the house on-board so that we could work with them directly.

The subcontractors were cooperative and willing to finish their work but it was still a protracted and sometimes frustrating process. Simon and Jenny were by now living abroad, which complicated things further, but their attitude remained excellent throughout. It's interesting to see how people react to a crisis and we were blessed to have such level-headed people as clients; calm, rational and supportive.

The most unfortunate result of the whole affair was the house's airtightness, which failed to meet the level required for passive house certification. The builder was distracted by his financial difficulties and the airtightness layer's integrity suffered; smoke tests identified the faults but with the house now at last complete, Simon and Jenny decided against opening-up to correct them.

Even allowing for this, our as-built PHPP calculations show a specific space heat demand of 14 kWh/m^2/yr and a specific primary energy demand of 47 kWh/m^2/yr; so while not the fully-certifiable passive house originally hoped for, it's a near-passive house that should be very comfortable to live in ▶

“While not the fully-certifiable passive house originally hoped for, it’s a near-passive house that should be very comfortable to live in and cheap to run”

and cheap to run. It has high levels of insulation (roof, wall and floor U-values average around 0.11 W/m²K) and minimal thermal bridging; its thick polished concrete floors provide thermal mass; hot water comes from the sun and a wood-burning stove when needed in winter; rainwater is harvested and filtered to drinking standard for use in basins, baths and showers. It features a double-height living space around which the whole house revolves and it has a rich variety of connections to the outside world; windows and roof light frame views of surrounding gardens, trees and sky, while shafts of sunlight prowl beguilingly around the house throughout the day.

(above) The double-height main living space around which the whole house revolves

(opposite) large windows and roof lights allow plenty of sunlight into the house, while also providing views of the garden and sky

FSC certified European Oak was used for all joinery and timber flooring; (p51) this timber frame house is a compact and simple design which made it easier and more cost-effective to aim for the passive house standard

SELECTED PROJECT DETAILS
Clients: Simon Kennedy, Jenny Howe
Architects: Fitzpatrick & Mays Architects
Mechanical contractor: Heat Doc Ltd
Airtightness tests: GreenBuild
Indicative BER: 2eva.ie
Cellulose insulation & airtight tapes in roof: Isocell
Floor insulation: Kingspan Insulation
Airtightness tapes in walls: Isover
Airtightness membrane: Gerband
Sheep's wool insulation: Ecological Building Systems
Plaster board: Fermacell
Organic paints: Auro
Windows, doors & rooflight: Jens Kuechenmeister
External render: Knauf
Heat recovery ventilation: Pure Renewable Energy
Solar thermal array: Kingspan Renewables
Rainwater harvesting: Molloy Precast
Wastewater disposal: Biorock system supplied by TEC
Electrics: Lawlor Electrical
Lighting design: Wink Lighting
Joinery: Oikos Furniture Ltd
Kitchen: Rhatigan & Hick
Tiling: Gerard Benson
Painting: Kelly and Thompson
Stone paving: Banagher Stone
Polished concrete floors: Concrete Concepts
Landscape design: Howbert & Mays

PROJECT OVERVIEW:

Building type: 189 sq m detached two-storey timber frame house

Location: Old Downs Rd, Kilpedder, Co Wicklow

Completion date: June 2012

Budget: Contract sum €390,000

Passive house certification: Not submitted for certification as airtightness test results didn't achieve the required level. The figures in the following sections are from our as-built PHPP using the airtightness test results achieved

Space heating demand (PHPP): 14 kWh/m²/yr

Heat load (PHPP): 12 W/m²

Airtightness: 1.45 ACH at 50 Pa

BER (indicative rating): A3 (59 kWh/m²/yr). The client is considering the installation of solar PV panels which would affect the result

Thermal bridging: all elements of the envelope were insulated externally to minimise thermal bridging, as described in the following sections

Ground floor: 100mm polished concrete on 200mm concrete raft on 250mm Kingspan Styrozone H350R insulation, wrapped up outer face of raft at edges. U-value 0.112 W/m²K

Walls: factory-built timber frame with 80mm wood fibre insulation board externally finished with Knauf acrylic render, over 220 x 60 cellulose-filled timber studwork, followed internally with 18mm OSB taped & sealed with Vario MultiTape SL, 50mm service cavity insulated with Thermafleece sheep's wool insulation, and 13mm. Fermacell board on 11mm OSB. U-value: 0.122 W/m²K

Roof: Protec glass fibre waterproofing layer on 240mm Kingspan TR27 insulation on vapour control layer on 18mm OSB deck, ex 38 x 38 tilting fillets, 220 x 60 timber joists, followed underneath by Gerband SD2 Control airtightness membrane & Isocell Airstop tapes, 50 mm service cavity and 12.5mm plasterboard ceiling. U-value: 0.097 W/m²K

Windows: Nestle Climate Window HA triple-glazed aluminium-clad timber windows with argon filling. Overall U-value: 0.74 W/m²K

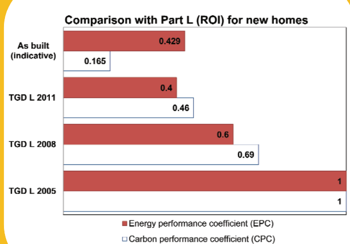
Heating system: 60 Kingspan Thermomax solar vacuum tubes and Olsberg Tolima Aqua Compact 10kW room-sealed wood-burning stove with back-boiler (70% of stove's heat output goes to hot water) supplying underfloor heating and 500 litre combi tank

Ventilation: Paul Focus 200 heat recovery ventilation system, Passive House Institute certified to have heat recovery rate of 91%

Lighting: a mix of low energy lighting including CFLs, LEDs & IRCs with dimmers

Green materials: Fermacell dry lining board; cellulose, sheep's wool and wood fibre insulation; Auro organic paint. FSC certified European Oak used for all joinery and timber flooring, finished in Osmo Polyx white oil

Landscaping: all boundaries planted with native hedging species of hawthorn, hazel and holly. Green manure crop of two seeds of clover mixed with an ornamental crop of wildflower seeds sewn to improve disturbed soil following building works. Edible landscaping includes planting of apple trees, plum tree, pear tree, blueberry bushes and a walnut tree



Islington centre

gets award-winning passive

A community centre in a deprived area of north London has become one of the few buildings in the UK & Ireland to get passive house certification with a renovation.

Words: Lenny Antonelli

Most architects tasked with turning a run-down, 19th century building into a modern community centre would do the obvious thing: knock it and rebuild. A different fate was chosen for Mayville Community Centre.[1]

This concrete-framed, brick-clad building in Islington was originally a generating station for London's tram network. The Mildmay Community Partnership saved it from dereliction in 1973 — demolishing their home was not an option.

"There are quite a few longstanding members who absolutely adore that building," says centre manager Teena Phillips.

The centre does most of the things you'd expect from a community centre: runs classes, helps local traders, connects kids with older citizens, and provides a space for community groups, from an over 50s social club to childcare and singing groups. Mildmay is one of the most deprived areas in London.

The building was "old, dingy, dark, cold" before, Teena says. Energy bills were sky high, there was no insulation, and much of the building was unusable.

So passive house experts Bere Architects set

upgrade

Photos: Tim Crocker Photography / Bere Architects

out to do what many others have failed to achieve: full Passive House Institute certification with a retrofit.

Enerphit certification — the Passive House Institute's less onerous standard for retrofit projects — didn't exist when the renovation was first mooted, so it was either full certification or nothing.

Architect Justin Bere says he proposed going for passive as "the most reliable means to make the building warm and comfortable with minimal energy bills".

Hitting passive house targets for airtightness and thermal bridging can be particularly difficult with an old building.

"Enerphit hadn't been devised as a concept at the time and we didn't feel particularly challenged. We had confidence that with knowledge, diligence and collaboration we would succeed," he says.

Bere Architects decided to wrap the walls in Permarock EPS external insulation, which envelopes the building and cuts out thermal bridges — gaps in the insulation where heat can escape, such as where internal floors meet the external wall. Because the building is free standing, it was possible to dig down and insulate around the basement too. New balconies and steelwork on the south facade were also thermally isolated from the building.

The team wrapped the roof in a DuPont Tyvek membrane for airtightness and vapour control. For the walls, the parge coat used to glue and mechanically fix the external insulation to the external walls also acts as the airtight layer.

The trickiest airtightness detail was over the old roof trusses, but Justin Bere says it was ▶

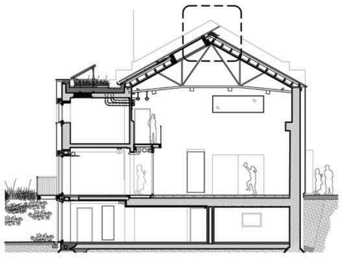
(above) all viable space for solar PV is exploited, including the roof of the single storey extension; (below) the new zinc pitched roof, filled with 400mm of insulation; (bottom left) external insulation was applied to the walls right down to the foundations to reduce thermal bridging; (bottom right) the renovated centre allows members of the community to meet and socialise in a comfortable environment

easily dealt with by planning ahead. "Preparation in design and construction is all that's needed," he says, "care rather than any particularly unusual level of cleverness."

Bere Architects designed a new zinc pitched roof which was filled with 400mm of Rockwool insulation, while the two flat roofs were insulated with 300mm of Foamglas, a type of cellular glass insulation. Each was also topped with soil and planted with native wildflowers to boost biodiversity and reduce rainwater runoff.

Insulating under the ground floor wasn't possible, so the team did the next best thing — externally insulated the walls right down to the foundations to cut out thermal bridging, and installed 75mm of Kingspan insulation on the basement's concrete raft.

They ripped out the building's draughty old single-glazing and installed new triple-glazed, thermally broken Passive House Institute certified Bayer windows and doors, bracketed onto the face of the external walls to keep level with the external insulation and taped for ▶



1a NBS H74 120
Zinc standing seam roof, Underlay on 18mm WBP birch plywood deck

1b 60x60mm SW battens @ 600mm centres insect mesh to ventilation openings

1c NBS P10 256
100mm Rockwool Rockfall Overlay board insulation fixed via battens to SW purlins.

1d 300x50mm SW purlins @ 600mm centres, supported to u/s by galv steel angles to St Eng's details

1e NBS P10 144
3x100mm Rockwool Flexi insulation fitted between 300x50mm SW purlins.

1f 18mm OSB

1g NBS P10 312
Tyvek SD2 Air tightness membrane

1h 12mm Plasterboard ceiling soffit.

2 Existing steel truss with 100x50 RHS welded to top chord to S.Eng design and specification for details.

3 Puren insulated plinth to support and fix Velux Rooflight screw fixed into timber trimmers.

4 NBS P10 146
Mineral fibre insulation to cavities.

5 NBS P10 325
Tyvek Supro Breather Membrane. Membrane to be fixed via 60x60mm SW battens through to 300x50mm SW purlins.

6 50x50mm SW battens

7 NBS L10 465
Triple glazed fixed rooflight, set into stainless steel angle frame, supported on 18mm birch ply packers on SW window head.

8 100x100mm stop batten for edge of overlay board and for fixing puren plinth skew nailed to trimmers and with 30x2.5mm thick bat strap at 500mm c/c with 4no. 40mm screws.

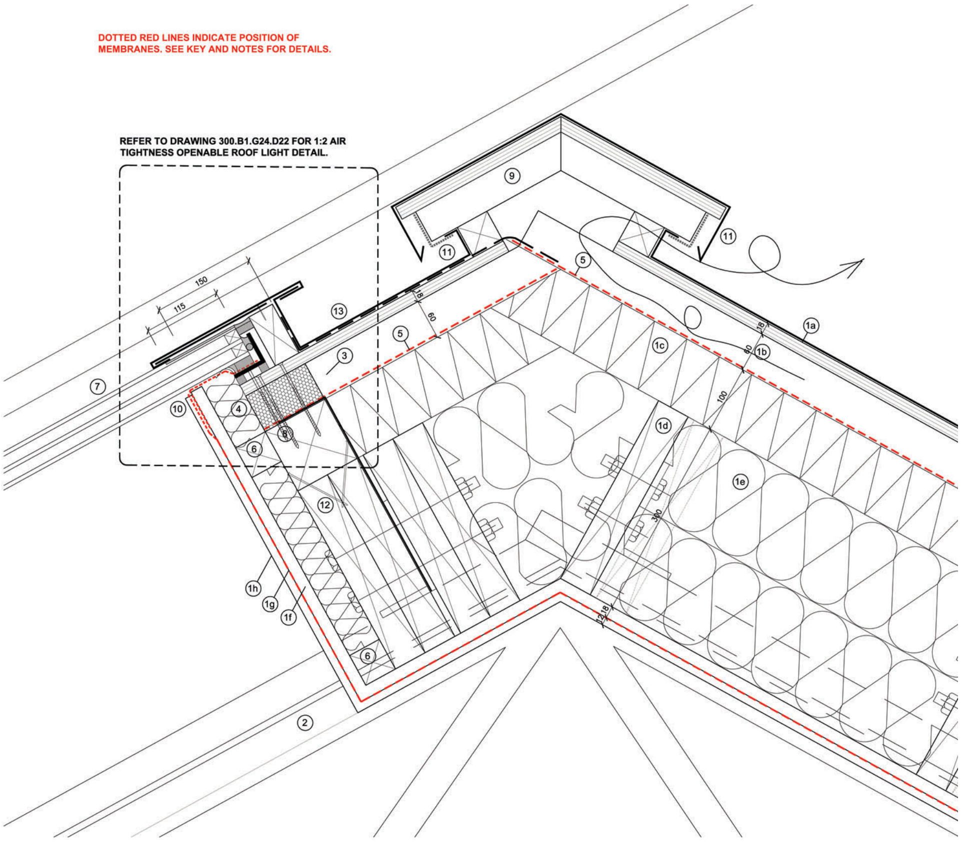
9 NBS H74 Ventilator ridge

10 NBS L10 815
Tyvek tape to seal air tightness membrane to roof light frame

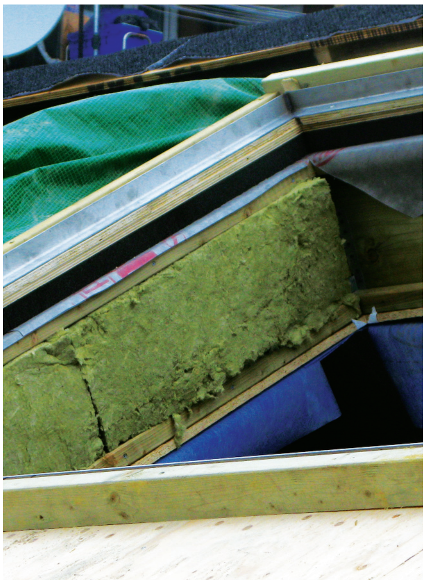
11 Insect mesh to ventilation openings.

12 300x50mm SW trimmers to form opening for velux window.

13 Zinc flashing to valley gutters, turned up and over top pane of fixed glazing, by Zinc sub-contractor.



(above & below) meticulous cold bridging detailing around the south-facing roof lights; (bottom) thermal imaging reveals a marked difference between the upgraded centre and the surrounding buildings



airtightness. Triple-glazed roof lights were put in too — again with well-worked details for airtightness and cold bridging.

The building was also kitted out with renewables —a new Viessmann ground source heat pump replaced the old gas boiler.

When heating is needed, it's delivered by regular old radiators. These were deliberately oversized, which means they can deliver enough heat while running at a lower-than-normal temperature of about 45C. This makes them more compatible with a heat pump, which are more efficient when delivering heat at lower temperatures. Three square metres of solar thermal panels on the roof also help generate hot water for the building.

The centre also has a huge array of electricity-generating Sharp solar photovoltaic (PV) panels on the roof— 77 panels over an area of 127 square metres.

"At the time it was one of the biggest ones we'd done," says Ollie Davenport of PV supplier The Energy Warehouse. "It seems to be working well, it's producing what it should be producing."

Lighting is a mix of low-energy CFLs and conventional fluorescent tubes. Though anyone can turn the lights on with a switch, they dim automatically when there's enough sunlight getting in, and shut off if a room is empty.

Rainwater harvesting systems collect rain that falls on the roofs, filter it and deliver it to toilets and for the garden and food growing.

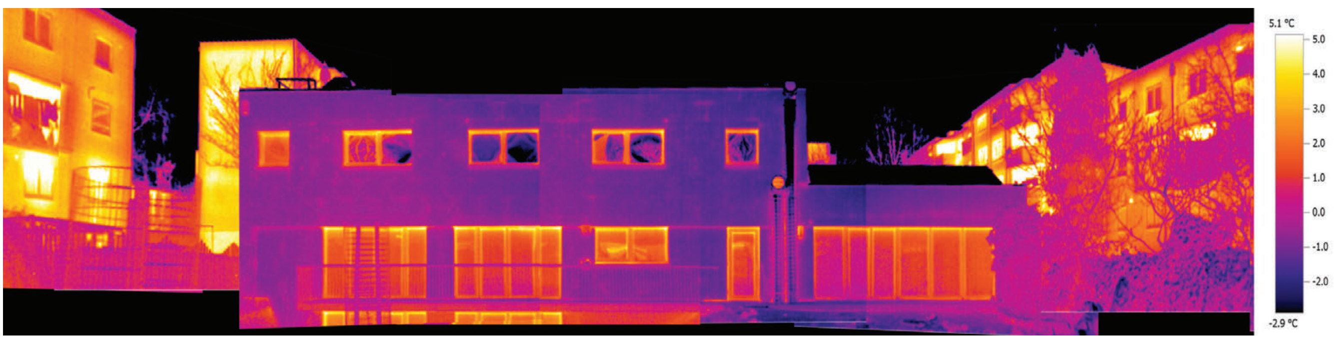
Swift, sparrow, wren and bat boxes have also been installed within the external insulation.

As with all certified passive buildings, heat recovery ventilation extracts stale air and uses it to pre-heat incoming fresh air. Anecdotally, it seems to be making a big difference inside.

Centre manager Teena says the building has a "light, airier feeling to it" now. Since the renovation, she says there's no longer a 3pm rush for coffee. She doesn't pick up as many colds before either, she says, or feel as tired.

"Working in that building [before] was cold, damp and dingy," she says. "The office environment does play a big part in illnesses and that I think."

To create more space, Bere designed a new entrance block and dining area. The team excavated around the basement and created a south-facing light-well here that delivers sunlight and ventilation, turning it into a functioning workspace. ▶



Teena says before the building was always too hot or too cold, but now she's never even aware of the temperature — it's just comfortable.

"This is really our first year getting used to the building and everything," she says.

Teena wants to use the building as a tool to educate the local community about buildings, energy and the environment, and the centre has teamed up with University College London on a project that aims to do just that.

Before the renovation the building was consuming 581 kWh/m²/yr — the renovation is estimated to have cut this to just 120 kWh/m²/yr, and less just 10% of that is for space heating. The building's net CO_2 emissions are now almost five times less than they were before the renovation. And the running cost data looks very promising too.

The ground source heat pump is the only specific heating source in the building. For the 12 months from January to December 2012 the total spent on electricity to run the heat pump was £328.20 – and even that is a worst case scenario figure, based on calculations using the higher day time rate of electricity. This total expenditure has been worked out on actual metred usage from the heat pump and doesn't take into account electricity from the solar PV array. As the PVs provide approximately 36% of the total building's energy consumption, it's estimated that the actual cost to heat the 665 sq m centre in 2012 was nearer £210.

Bere Architects even moved their own offices into the building, which has won a plethora of awards[2]. "I'm constantly amazed at how warm and comfortable the building is in winter, and how cool and comfortable in summer with little or no effort by the users, and with tiny amounts of energy input," Justin Bere says. "Passive house works better than I dared hope."

SELECTED PROJECT DETAILS
Clients: Mildmay Community Partnership
Passive house consultant: Bere Architects
Passive house certification: BRE
Structural engineers: Conisbee
M&E engineers: Alan Clarke
Quantity surveyor: e-Griffin Consulting Ltd
Post occupancy evaluation partner: BSRIA
Airtightness tester: Gaia Aldas
Sbem calculations: XCO2 Energy
Lighting design: GIA Equations
Green roof designer: Dusty Gedge
Main contractor: Buxton Building Contractors Ltd
External insulation system: PermaRock Products
Insulated foundation system: Kingspan Insulation
Mineral wool insulation: Rockwool
Rigid board insulation: Foamglas
Windows:
Bayer Windows, supplied by Doublegood Windows
Openable roof windows: Velux
Fixed roof windows: Isaacs Glass Co. Ltd
Airtightness tapes:
Tremco Illbruck, supplied by Bayer
Breather membrane: DuPont Tyvek
Thermal breaks: Schöck
Rainwater harvesting: Aquality Trading & Consulting
Solar PV: The Energy Warehouse
Heat pump & Solar thermal: Viessmann Ltd
Heat recovery ventilation: The Green Building Store

[1]The building was recently renamed Mildmay Community Centre in recognition of the centre's growing significance in providing community services for the whole of the Islington Mildmay ward
[2]In 2012 the Centre won the retrofit award at the UK Passivhaus Awards, the building performance award at the Constructing Excellence in London and the South East Awards and the leisure award at the Greenbuild Awards. It had won the best public building award at the 3R Awards in 2011.

PROJECT OVERVIEW:

Building type: 665 sq m Victorian solid masonry building, originally housing electricity generators supplying the London tram network. Now a community centre.

Location: Islington, north London

Project budget: £1.6m

Passive house certification: full certification achieved

Space heating demand:
Before: 581kWh/m²/yr if 21oC maintained in winter, but in reality that was not affordable, so 272 kWh/m²/yr with low internal temperatures in winter
After (PHPP): 12 kWh/m²/yr

Primary energy demand (PHPP):
Before: not calculated
After: 120kWh/m²/yr. Of this only 12kWh/m²/yr) will be used for space heating, with an approximate annual cost of £600

Energy performance certificate (EPC): not calculated

Heating bills:
Before: Gas bills of £5900 per annum
After: £328 (Jan-Dec 2012) calculated based on meter readings from heat pump - or an estimated £210 taking into account solar PV contribution

Airtightness (at 50 Pascals): 0.43 ACH

Existing building walls:
Before: 450mm uninsulated brickwork
After: (above ground) 290mm Permarock EPS external insulation, 10mm render finish, U-value 0.116 W/m²K. (below ground) 200mm external XPS insulation to existing brick walls. U-value: 0.154W/m²K

New extension walls: single-storey blockwork wall construction, 15mm internal plaster, 215mm blockwork, 290mm EPS insulation, 10mm render, U-value: 0.119 W/m²K

Pitched zinc roof: 15mm plasterboard, 18mm OSB, 300mm Rockwool Flexi fitted between the structural timbers, 100mm Rockwool Rockfall overlay board with breather membrane, Tyvek Supro installed on top, 50mm timber battens, 20mm standing seam zinc roof finish on 20mm timber substrate. U-value: 0.109 W/m²K

Green roof: high level flat roof: 300mm Foamglas insulation on existing concrete roof slab with asphalt covering and 100mm soil and meadow planting. U-value: 0.130 W/m²K

Low level flat roof: 300mm Foamglas insulation on new timber roof structure with 20mm asphalt layer and 100mm soil and meadow planting. U-value: 0.131W/m²K

Floor: New entrance floor slab 300mm Foamglas insulation and concrete slab. U-value: 0.129 W/m²K

Existing basement floor slab 300mm existing slab with 80mm Kingspan insulation and floating floor. U-value: 0.256 W/m²K

Windows & doors:
Before: single-glazed, draughty windows and doors.
New windows: Triple-glazed Bayer Passive House windows with thermally broken timber frames. U-value: 0.6 W/m²K

New openable rooflights: Velux, electronic, timber framed, triple-glazed passive house units.

New fixed rooflights: Isaacs Glass Co, triple-glazed glass units. U-value: 0.9 W/m²K

Entrance door triple glazed Bayer Passivhaus automatically opening glass with thermally broken timber frames U-value 0.85 W/m²K

Airtightness:
Airtightness sealing tapes between window frames and internal airtightness layer /vapour control membrane, and window frames and first floor external breather membrane.

Airtightness and vapour control layer to provide continuous envelope around building envelope in plan and section. Airtight layer for walls is parge coat used to fix insulation to external walls. Airtight layer for roof is Tyvek membrane.

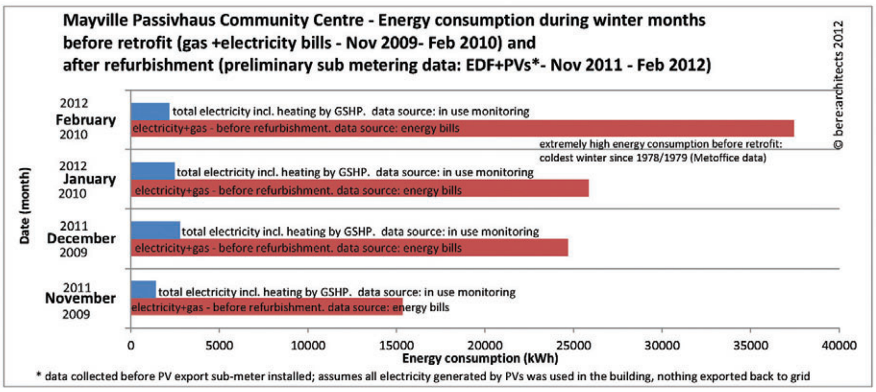
Heating system:
Before: industrial gas boiler
After: 8.4kW Viessmann Vitocal 300-G ground source heat pump with 140m double pipe trench

Ventilation:
Before: no ventilation system, reliant on infiltration and opening of draughty windows for air changes.
After: Paul Maxi 2000

Green materials: (to all internal surfaces) untreated softwood used throughout, birch plywood, natural linoleum floor finishes.

Microgeneration: 126m² of photovoltaic panels 77 no.NU235E1 Sharp Panels 235W = 18kWp

Solar thermal: 3m² Viessmann Vitosol 200 solar array



Dublin semi-D

sets deep retrofit example

A house in south Dublin recently became the first Irish building to become EnerPHit certified. Architect **Joseph Little** describes the challenges of meeting the Passive House Institute's standard for upgrading existing building.

Deep retrofit is the future, but we've a lot to learn. The term deep retrofit refers to an energy-efficiency upgrade that achieves dramatic savings on existing use of between 50 to 90% using an integrated approach with attention paid to airtightness, summer overheating and ventilation – and not just super insulation.

While new buildings can be sequenced to maximise thermal continuity, airtightness and speed of construction, several factors complicate the works and impinge upon the performance possible in deep retrofits. Sub-optimal orientation and constructon methods, old rising walls, intermediate floors and decorative features of a bygone era – the list is long and formidable. The more of the old fabric that's stripped away, the more 'sins of the past' become evident – and the more control is gained to ensure the desired standard is met. Yet the building becomes less and less an old building and if the issue isn't addressed the associated embodied carbon emissions can rise significantly in spite of a great reduction in energy in use.

Though energy costs are constantly rising, they may still be too cheap to prompt enough owners to take the action needed to meet national climate change targets and provide sufficient security against future fuel prices. Highlighting the value gained in comfort, health and quality now – with greater financial security thereafter – will only galvanise so many private building owners. Governments know deep retrofit is the most sensible approach and they know this needs to be implemented everywhere. Shallow retrofits are problematic in that earlier measures may prevent – or have to be stripped-out to facilitate – later measures. If the EU's building stock is to be made nearly climate neutral by 2050 yet the building fabric of most buildings is only retrofitted every 30-40 years, it's clear that all retrofits undertaken now should meet the targets and compensate for those buildings that won't or can't. Philip Sellwood of the UK Energy Saving Trust[1] estimates that one dwelling must be retrofitted per minute – and the interventions done right each time – if the UK's 2050 targets are to be met. Ireland must be similar. Yet Irish energy efficiency grants end in 2013 and the government is following the UK in obliging energy providers to take a central role in this space while encouraging energy users at every scale to get the right works done, and done right. Not an easy task.

Photos: bNEW Photography

As scale is a great way to make deep retrofit more affordable, the authorities could focus on terraces and districts with building types that allow a collective approach – many in older suburbs and disadvantaged areas. Such work could be used as a key way to reduce our dependency on fossil fuels, while aiding community resilience and alleviating fuel poverty – a chronic condition that's under-reported in Ireland. This is not to mention the value in upskilling construction workers, increasing tax take and encouraging local innovation in this sector. Another challenge is to carry out retrofits without losing the character of traditional buildings and the districts or urban blocks they're in[2]. It's clear that deep retrofit to EnerPHit standard or equivalent throws up a host of issues. To understand and start to resolve these we need built examples.

Ireland's first certified EnerPHit

My practice recently completed a good example of the issues at the centre of deep retrofitting to a clear standard: a 111 sq m 1950s semi-D in Monkstown, Co Dublin upgraded to the EnerPHit standard, with a 48 sq m extension built to the passive house standard. The building has just been certified Ireland's first – and the world's fifth – EnerPHit project. The house's owner Pauline Conway first approached us because we were the first practice to be accepted into Éasca – an Irish green building association that approves companies with sufficiently strong sustainability credentials. She wanted partners in a plan to make her house an educational tool and an example of genuinely sustainable retrofit. The project started on site in April 2011.

While we knew that achieving this standard would set an important example for ordinary semi-detached houses, we also wanted to promote healthy ventilation, water conservation and low carbon forms of construction, as we strongly believe energy should not be pursued in isolation. Pauline grew up in a remote part of rural Ireland. "Until the age of eight years I lived in a house without piped water," she says, "where we had to carry buckets of drinking water from a nearby stream and harvest rainwater for laundry". She therefore gained a keen sense of the importance of natural resources. Later she spent 13 years working in African countries. In Ethiopia she saw at first hand the horrific impact of recurrent droughts which are increasing in frequency due to climate change, largely caused by developed countries. She wanted her home to be an example of genuine sustainability.

The design

Our aim was that from the street the retrofitted, extended semi-detached house would continue to fit into its suburban context, while small elements such as the juliette balcony and anodised rainwater goods would suggest that something special was within. The rear extension is more clearly different as it orientates exactly to south then curves away to frame a dining table within and a deck without.

Sunpipes, roof lights and windows extended downwards to become patio doors, a glass screen between hall and kitchen and an open riser stairs with glass balustrade all contribute to even light distribution throughout the house. All services are clustered in the extension, simplifying services runs. A solar panel faces south west on the rear roof.

Before and after, values, monitoring

Given the project's aspirations we established a baseline with a before Building Energy Rating (BER), an airtightness test and thermographic study. Architect Helena McElmeel is carrying out a study pre and post-works as part of the RIAI 3Twenty10 research project. Despite the more than three hundred thousand published BERs there is extraordinarily little known about how Ireland's dwellings actually perform and are actually used after retrofit.

We established that the initial airtightness of the house was 5.6 air changes per hour at 50 pascals. While this seems an amazing value for an old house, levels close to this may be more common than realised for older buildings that were well built and have not been interfered with. The AVASH study[3] of thirty-two social housing dwellings in Leinster established an average airtightness for the existing, untouched housing stock it studied (mostly from the 50s and 60s) of 7.98 ACH, while those that had been retrofitted averaged an appalling 13.3. Heat can be lost quicker through gaps and cracks than in conduction through insulation, especially in windy countries like Ireland, so it's very important that baseline conditions are understood and improved upon in retrofit work.

The air barrier of the semi-detached house is mostly the original wet plaster. The attic had been very carefully-insulated in the 1980s, with now mostly collapsed mineral wool, and had been carefully re-glazed more recently. Surprisingly, for the airtightness value achieved, the timber floors were suspended: presumably the underlay was thick and dust-filled!

Low carbon and timber

A key low carbon approach in the project was using wood-based products when possible. Using wood in construction ensures that carbon captured through photosynthesis (becoming the very stuff of trees) remains bound-up, and it's also a great insulant. We love the fact that cellulose insulation was newspapers which had been trees: well-read material saved from burning and landfill.

We used 220mm FSC-certified timber studs for the extension's walls, clad internally with 18mm OSB3 as a racking board and airtightness barrier, and slabbed externally with 80mm thick Diffutherm woodfibre external wall insulation. We then blew cellulose into the resulting cassettes between[4]. The flat roof was similar except that Gutex woodfibre slabs were used over joists. The main cold roof buildup featured 400mm of cellulose. In all 56 m³ of cellulose and 11 m³ of woodfibre were used.

Higher embodied energy – low carbon response

Before adopting EnerPHit we had intended to insulate under the suspended timber floor in the usual manner for retrofits. In moving to ▶

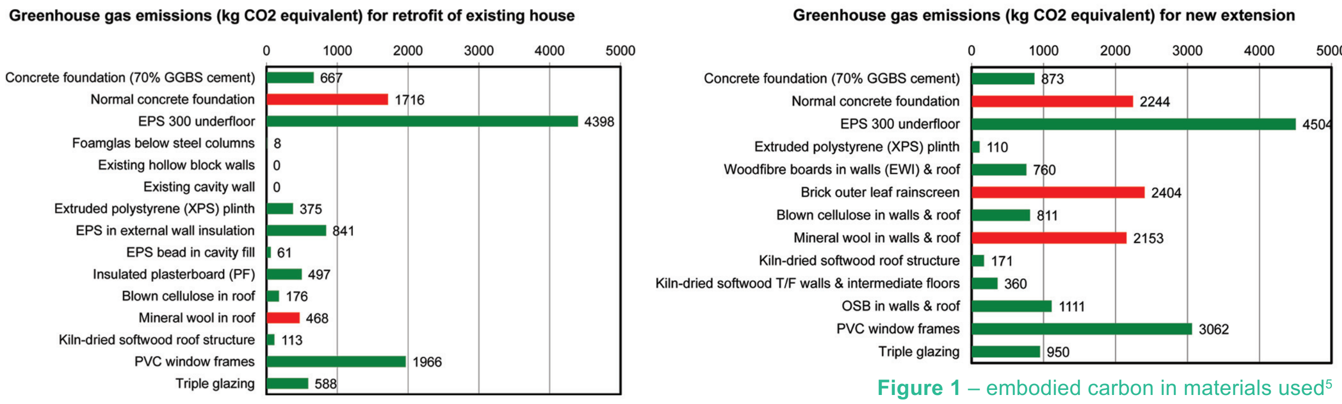
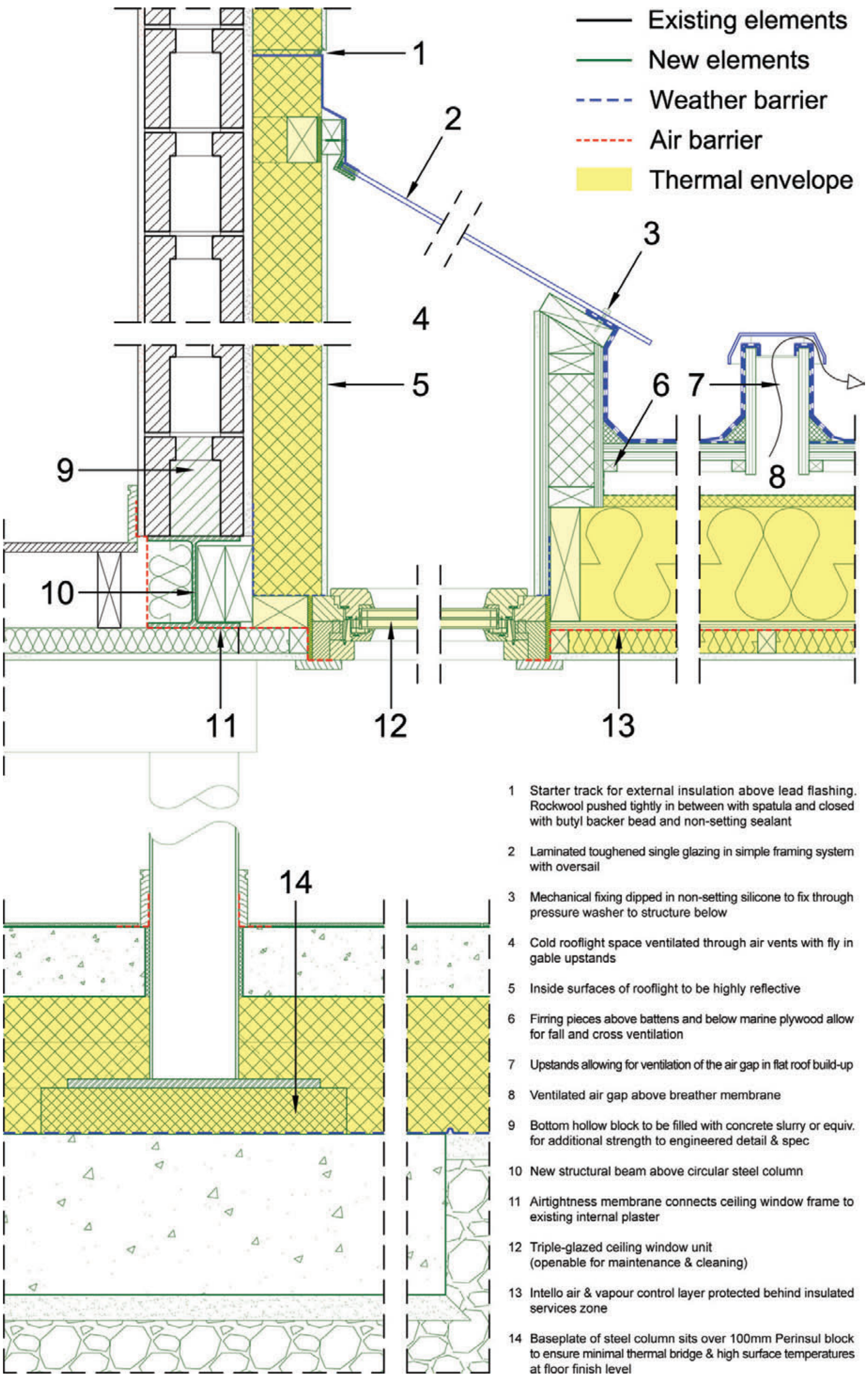


Figure 1 – embodied carbon in materials used[5]

(left) and (p63) the rear extension orientates exactly to south then curves away to frame a dining table within and a deck without

(p62) the externally insulated front of the new extension & original house are in keeping with the sub-urban context



1 Starter track for external insulation above lead flashing. Rockwool pushed tightly in between with spatula and closed with butyl backer bead and non-setting sealant

2 Laminated toughened single glazing in simple framing system with oversail

3 Mechanical fixing dipped in non-setting silicone to fix through pressure washer to structure below

4 Cold rooflight space ventilated through air vents with fly in gable upstands

5 Inside surfaces of rooflight to be highly reflective

6 Firring pieces above battens and below marine plywood allow for fall and cross ventilation

7 Upstands allowing for ventilation of the air gap in flat roof build-up

8 Ventilated air gap above breather membrane

9 Bottom hollow block to be filled with concrete slurry or equiv. for additional strength to engineered detail & spec

10 New structural beam above circular steel column

11 Airtightness membrane connects ceiling window frame to existing internal plaster

12 Triple-glazed ceiling window unit (openable for maintenance & cleaning)

13 Intello air & vapour control layer protected behind insulated services zone

14 Baseplate of steel column sits over 100mm Perinsul block to ensure minimal thermal bridge & high surface temperatures at floor finish level

Figure 2 – detail showing how the upper floor of house is supported and differentiationof weather barrier and insulation continuity at the roof light

EnerPHit we realised that the resulting U-values wouldn't be good enough. In any case as the insulation depth increased beyond the joist depth the repeat thermal bridges would get worse. Instead we stripped out the joists and tassel walls, laid a radon barrier on the original subfloor and built up 300mm of EPS300, then poured 150mm of concrete with 70% Ecocem GGBS on top. This gave us a retro-fit floor U-value of 0.11 W/m^{2}K.

Clearly the thermal performance and ability to control quality greatly increased, but the amount of floor and sub-floor materials going to land-fill also increased because of this decision. We knew the use of low carbon concrete, wood fibre and recycled products would compensate but it is striking that the EPS300 slab insulation had a greater carbon impact than expected. Its density means that the amount of EPS contained is much greater. In subsequent projects it'll be interesting to see if alternative insulants below slab can improve on that carbon impact, and at a reasonable cost. The embodied carbon of the uPVC window frames is also worth noting.

Figure 1 should only be considered a rough, incomplete estimate of associated CO_2 (equivalent) emissions: the impact of the membranes, renders and finishes, for example, are omitted. We deliberately show a few alternatives such as mineral wool in the attic or brick rain screen (highlighted in red) to illustrate how swapping approach and specification can allow an equal or better performance, yet less carbon. We look forward to the imminent publication of SEAI's embodied energy and carbon measurement methodology and database which should make this kind of analysis, and resulting low carbon-focused specification, more common and more Ireland-specific.

The steel column – a key point thermal bridge

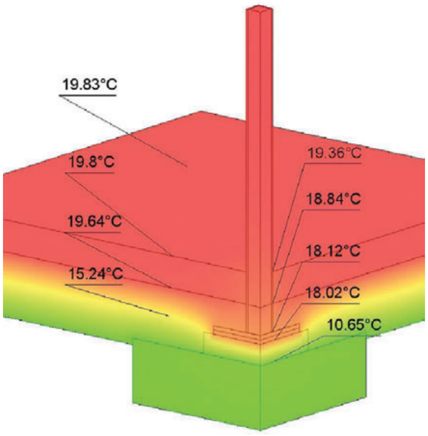
A key technical issue that had to be resolved was how to bring the load of the rear corner of the first storey to ground in a 'thermal bridge free' way[6] once the ground floor walls were removed to make way for an open plan space below. Figure 2 shows the column, the wall it's supporting above and the footing below. It also shows how the line of thermal continuity and water management are separated at the rooflight, minimising thermal bridging and airtightness issues there.

We worked closely with engineers Malone O'Regan to arrive at a final solution featuring an unusually large base plate that transferred a uniformly distributed load of the column onto a 100mm Perinsul Foamglas layer onto a concrete pad. Figure 3 shows an output from a point thermal bridge evaluation using the newly translated Psi-Therm software. Note the temperature at the junction of floor and column (19.36C) is only 0.5 K cooler than the floor elsewhere.

Managing airtightness & delivering quality

For this project we ensured that only builders who had built to an n50 of below 2.5 air changes per hour could tender. We provided a detailed airtightness specification, clear red-lined drawings and toolbox talks with technical support from Ecological Building Systems. Prime cost sums were allowed against each of three tests: one just after the air barrier had been formed but before first fix, the second after second fix and the third before practical completion was certified. Signing the latter certificate was

Figure 3 – point thermal bridge analysis of column base plate. χ-value = 0.041 W/K
Note: air temp. 20C, ambient ground temp. 10C



(above) the stick built timber frame extension being built (above right); OSB3 boards taped together and AVCL membrane connecting to OSB3 in floor above, with square tapes where cellulose had been blown in and insulated ducts

contingent on the builder meeting the design values.

Because the focus on airtightness was consistent and clear, and because the builder was facilitated and supported to reach the value through the support material and process created, there was little wriggle room allowed. It's critical that builders understand this beforehand, price soberly and put their A-teams forward. Design teams and clients need to judge this equally soberly and recognise that skilled teams and great care on site don't come with bargain basement tender prices. Perhaps knowing that a project must reach the EnerPHit standard gives all sides support at the critical tendering and contract signing stages.

We realised early on during airtightness tests that there was air leakage through some parts of some of the 18mm OSB3 boards[7]. To avoid a costly variation to the client if new AVCL membrane and tape were applied to the boards we contacted Remmers, a company that delivers conservation and breathability focused treatments and plasters. They suggested two roll-on coats of Induline ZW-400 might improve the airtightness of the boards. We advised the client and agreed to take a gamble on this approach. Airtightness tester Gavin Ó'Sé was able to prove that this improved the airtightness of the boards.

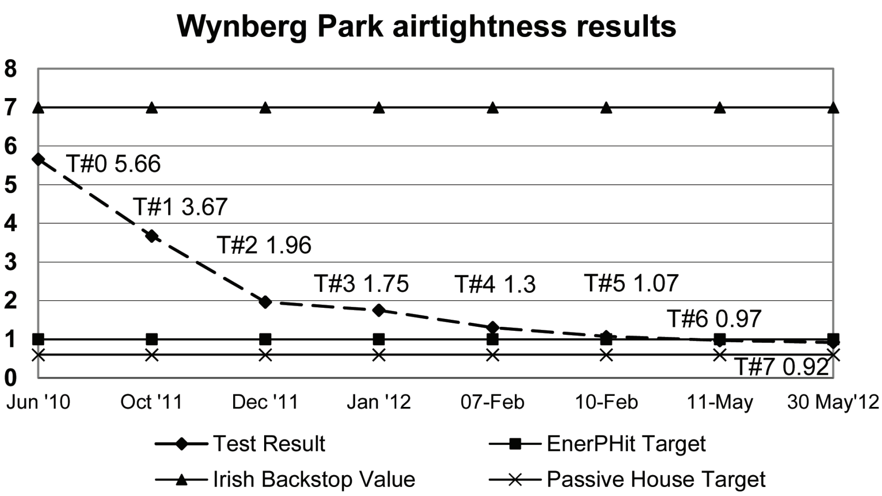


Figure 4 – the progress of airtightness tests

At the first construction stage airtightness test (an n50 of 3.67 ACH) it was clear that Bourke Builders had started to move ahead, slabbing insulated plasterboard at the party wall thermal bridges and first fixing. We instructed them to stop until the design airtightness value was reached. If it's not reached at this stage, when the layers of buildups and number of penetrations are relatively few and easily accessed, it never will be. Later tests are to ensure the value is maintained. There was clearly a learning curve on the specific difficulties of airtightness in retrofits. Diagnostic airtightness tests were crucial in helping us learn where under-performance was occurring and Bourkes took the appropriate corrective actions. We graduated from whole house testing to room by room testing using our hands, anemometers and smoke. It was only after the fourth construction stage test (an n50 of 1.3 ACH) that we allowed them to proceed to first fix as there were a few areas where improvements could yet be made unhindered by other works. In the end there were seven formal tests during the project and many more informal tests by the foreman using a Wincon fan. Bourkes paid for the additional tests. Their commitment to getting it right was central to the team's achievement of EnerPHit certification.

Water conservation
Dual flush toilets, low volume bath and bowls and sprinkler taps feature. We also worked closely with Ollan Herr of Reedbeds Ireland on the rainwater harvesting strategy. The location of tank and specification changed more than once but we were committed to a small gravity-fed tank within the building envelope. Herr is critical of the current vogue of overly large tanks buried in gardens requiring pumping over two storeys or more.

Located in an upper press of a walk-in-wardrobe, the system at Wynberg Park serves an outside tap and two toilet cisterns only. An outside leaf filter and two fine filters inside ensure the water is fit for purpose. Toilet usage typically comprises about 35% of a person's daily water demand. By focusing on supplying water for this function the size of the tank could be reduced to 450 litres, cutting out the need for electrically powered UV filtration. Locating the tank below gutter level but above toilet cistern height meant the system could be gravity fed. Because the tank's inside the house it requires no insulation. By using a simple water trap the supply is airtight. Finally fail-safe measures ensure the tank never overfills or empties. We liked the simplicity and technical elegance of this approach.

Moving forward
This project contained a range of innovations from timber frame wall system to overall performance specification, to rainwater harvesting approach. There was lots of learning – some through mistakes. The team got a number of things – such as meeting the EnerPHit standard – right and can prove it. That itself is a great message for building in Ireland.

The industry needs many more example cases of deep retrofit to a clear standard. All relevant bodies need to actively explore the challenges of deep retrofit and community scale retrofits, and then engage with others in transforming the construction industry. If we're serious about the 2050 targets, about reducing our oil and gas dependency and about genuine sustainability, we need to make significant changes in focus, policy and building culture in the next two years.

An extended version of this article is available from the author ▸

SELECTED PROJECT DETAILS
Client: Pauline Conway
Architect: Joseph Little Architects
Passive house consultant & BER assessor: Ann-Marie Fallon
Civil / structural engineers: Malone O'Regan
Quantity surveyors: Walsh Associates
Main contractor & timber frame: Bourke Builders Ltd
Airtightness tester: Greenbuild
GGBS cement: Ecocem Ireland
EPS 300: Kingspan
Thermal breaks: Thermal Insulation Distributors Ltd
OSB3 board: Coillte
Breathable sealing coat for OSB3: Remmers
Blown cellulose: Ecological Building Systems
Cellulose installation: Clioma House
External wall insulation system: Baumit
Diffutherm external wall insulation: Natural Building Technologies
Brick slips: Ibstock Brick (Ireland)
Windows & doors: Munster Joinery
Airtightness products: Ecological Building Systems
Gutex woodfibre insulation: Ecological Building Systems
Roof windows: Velux
Sun pipes: Fakro
Solar thermal supplier: Kingspan Renewables
Heat recovery ventilation: Pure Renewable Energy
Rainwater harvesting: Reedbeds Ireland
Flow Limiters: Armitage Shanks
Water conserving sanitaryware: Sandringham Fittings

[1] *The Retrofit Challenge: Delivering Low Carbon Buildings*, from Centre for Low Carbon Future and Energy Saving Trust, 2011. Available at http://www.energysavingtrust.org.uk
[2] Several EU-funded projects have focused on exactly this, e.g. 3Encult, Susref and Refurban.
[3] AVASH stands for *Advanced Ventilation Approaches for Social Housing*. DW EcoCo were the Irish partners of the three country project that ended in 2008. Papers can be found at www.brighton.ac.uk/avash/
[4] This is very different to the poor practice of slabbing EPS insulation outside timber frame which has caused failures in Canada and Sweden. The BBA-approved Diffutherm system for timber frame has been extensively tested and simulated for use throughout the UK. We believe this is the first time it's been used in Ireland.
[5] Green bars show materials used, red bars show materials and emissions avoided. Concrete values came from Ecocem Ireland Ltd, woodfibre values came from Natural Building Technologies. All other values taken from *Ökobilanzdaten im Baubereich 2009/1* jointly researched and published in Switzerland by KBOB, Eco Bau and IPB: www.kbob.ch
[6] As the Passive House Institute and indeed many EU member states measure buildings from the outside, a junction that they consider 'thermal bridge free' (i.e. <0.01 W/mK) may have a higher value when measured from the inside as per UK and Irish regulatory standards
[7] KU Leuven has carried out an interesting study on the airtightness of OSB boards from eight different manufacturers. They found that even within the same brand variation in airtightness can occur. It appears that even 18mm OSB3 cannot be expected to act as an air barrier at these design values.

PROJECT OVERVIEW:

Building type: 1960s semi-detached dwelling. EnerPHit retrofit to existing and passive house extension to side and rear.

Location: Wynberg Park, Monkstown, Co Dublin

Completion date: April 2012

Budget: €240k

EnerPHit certification: Certified

Building Energy Rating (BER)
Before: G (494.88 kWh/m^2/yr)
After: A3 (51.19 kWh/m^2/yr)

Space heating demand (PHPP)
Before: n/a
After: 17 kWh/m^2/yr

Heat load (PHPP)
Before: n/a
After: 12 W/m^2

Primary energy demand (PHPP)
Before: n/a
After: 109 kWh/m^2/yr

Airtightness (at 50 Pascals)
Before: 5.66 ACH
After: 0.93 ACH

Original walls: Rendered 215mm concrete hollow block wall. On ground floor (front elevation only) uninsulated cavity wall with exposed brick. All internally plastered. Average U-value: 2.40 W/m^2K
Retrofitted walls: Mineral render finish on 150mm Baumit Platinum EPS EWI on existing. On front ground floor cut-down brick slips to match existing brick over external wall insulation & cavity filled with platinum bonded blown bead. Renovated and extended existing wet plaster finish used as main air barrier. In rooms adjoining party wall 50mm insulated plasterboard internal wall insulation used additionally to minimise thermal bridging. Average U-value: 0.13 W/m^2K
Extension walls: External render, on 80mm Diffutherm woodfibre EWI with mineral render, on 220mm open panel timber frame filled with cellulose, on 18mm OSB-3 board, on 50mm Thermafleece PB20 sheepswool service cavity, on plasterboard. Taped OSB-3 used as main AVCL. U-value: 0.12 W/m^2K

Original roof: Pitched cold roof with 100mm mineral wool insulation between joists. U-value: 0.40 W/m^2K
Retrofitted roof: 350mm cellulose blown between and over joists, on Intello membrane AVCL, on plasterboard. U-value: 0.10 W/m^2K
Extension pitched roof: Pitched roof as per retrofitted roof.
Extension flat roof: Double butyl membrane on double layer of marine plywood, on 50mm ventilated air gap, on Solitex membrane, on 24mm Gutex woodfibre sheathing board, on 250mm timber joists filled with cellulose, on 18mm OSB-3 board, on Intello membrane AVCL, on 50mm insulated service cavity, on plasterboard. U-value: 0.13 W/m^2K

Original ground floor: Uninsulated suspended timber floor over ventilated undercroft with tassel walls and sub-slab
Retrofitted ground floor: Existing sub-slab under 300mm EPS 300, under 150mm concrete slab with 70% GGBS. U-value: 0.11 W/m^2K
Extension floor: Clause 804 aggregate with radon sumps under, radon barrier under, 400mm EPS 300, under 150mm concrete slab. U-value: 0.08 W/m^2K

Original windows & doors: double-glazed, air-filled PVC windows and doors to most of house. U-value: ~ 2.80 W/m^2K
New triple-glazed windows and doors: Munster Joinery triple-glazed Future Proof uPVC sash windows. U-value: 0.80 W/m^2K
Roof windows: Velux GGL/GGU thermally broken triple-glazed roof windows with thermally broken timber frames. U-value: 1.9 W/m^2K

Space heating & hot water system
Before: 20 year old oil boiler (circa 70% efficient) serving radiators in every room and two open fires.
After: The primary heating involves post-heating the HRV supply air. A 12kW modulating gas boiler providing back-up heat to a network of three small radiators, and two towel radiators zoned separately due to daily use. A 3.2m^2 Kingspan Thermomax HP 200 3M2 evacuated tube array on main rear roof facing south-west supplies hot water to a 300L 100mm factory-insulated cylinder (with triple coil allowing additional future heat source). A 12kW modulating gas boiler supplies the shortfall.

Ventilation
Before: rapid ventilation supplied by windows, no trickle vents, extract via pull chord unit in kitchen and chimney in living room
After: Paul Novus 300 VL (Passivhaus certified) HRV system, with recovery rate of 92.4% as installed. Primary air ducts are limited to 0.5m long with 100mm insulation

ABOUT THE AUTHOR

Joseph Little is the principal of Joseph Little Architects and Building Life Consultancy. He is a strong advocate of the use of scientific principles, better evaluation tools and rigour in designing and constructing new build and retrofit. The practice was an early adopter of low energy design principles. The consultancy is the Irish co-operation partner of the Fraunhofer Institute for Building Physics for use and development of Wufi software, and the promotion of numerical hygrothermal assessment in Ireland. He provides training courses within the RIAI and in industry. He has written and lectured on a wide range of construction, retrofit and evaluation issues in the UK and Ireland.

THE PASSIVE HOUSE *in a warming world*

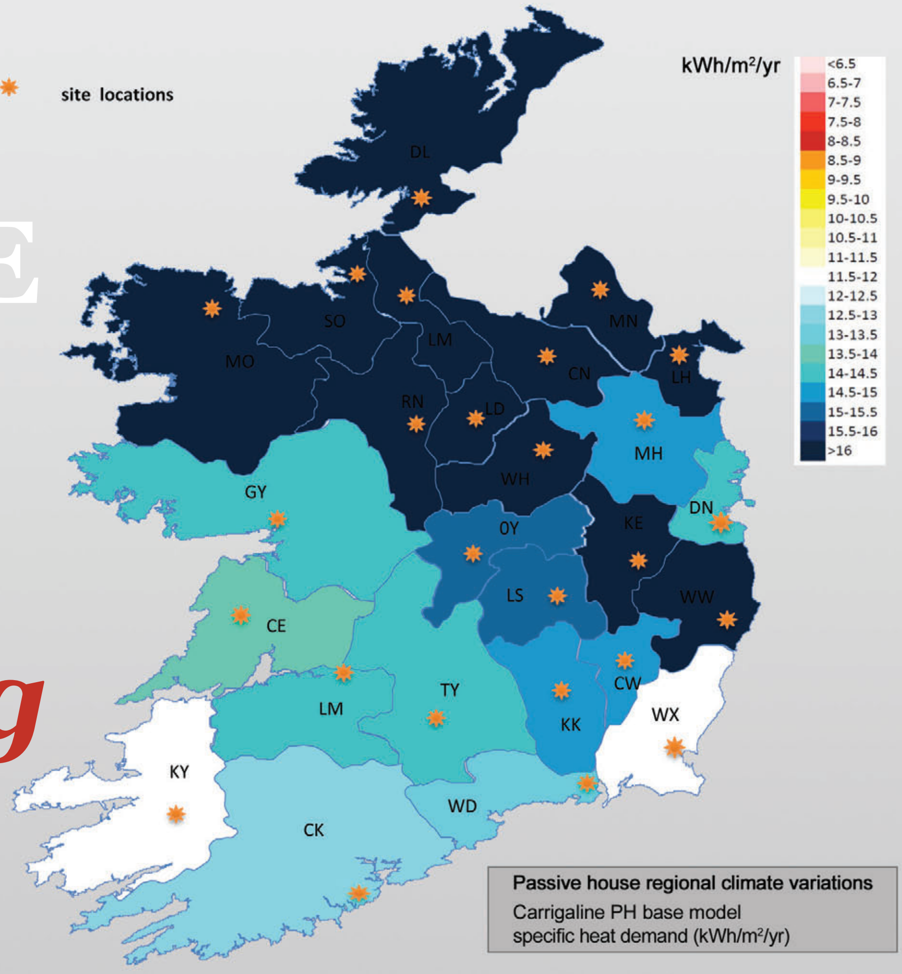


Image: Wain Morehead Architects

The coming decades are expected to bring higher average temperatures, more extreme weather events – and possibly more cold snaps. But how are passive house buildings geared to adapt to a changing climate?

Words: Lenny Antonelli

Passive buildings are meticulously designed to be warm and comfortable based on their local climate. But our climate is changing — so how will passive buildings in the UK and Ireland perform as the world gets warmer?

This is, of course, a complex question — a proper answer requires meticulous research and complex modelling by experts in climatology and building physics.

But some architects and energy experts are starting to think about how low energy buildings will perform on these islands as temperatures rise and the climate changes.

First, let's look at how the climate might change over the coming century. It's important to note that much of this modelling is quite uncertain.

Met Éireann, the Irish meteorological service, says the Irish climate is likely to get 3C to 4C warmer by the end of the century. Most of the warming will take place in summer and autumn, and in the south east. Autumn and winter will get wetter, but summers will get drier. Average wind speeds are not expected to change much in the coming decades, and are expected to get lighter towards the end of the century. But the frequency of intense cyclones — which bring heavy wind and rain —is likely to grow.[1]

The British Met Office's projections for the UK are somewhat similar: the country will get 2.5 to 3C warmer, and up to 10% wetter, though some parts of the south will get drier. Extreme rainfall events are expected to become more common there too.[2]

So what does all this mean for buildings, and low energy buildings specifically?

For a start, warmer temperatures should mean less need for space heating. "The heat demand will come down for most houses in the country," says energy consultant Andrew Lundberg of Dublin-based passive house consultancy Passivate, whose masters thesis examined how climate change will effect passive house performance in Ireland.[3]

Architect John Morehead, whose firm Wain Morehead provides ultra-local climate data for building project, modelled the annual heat demand of a passive house his firm designed in Carrigaline, Co Cork, under a warming climate up to 2100, and found it would fall from 12.1 to 9.3 kWh/m²/yr. "That is based on one particular dwelling," he stresses. "Every building will respond differently."

Rising temperatures will lead to big drops in cold related illness and death, according to the UK Government's 2012 Climate Change Risk Assessment, which predicted between 3,900 and 24,000 less winter deaths each year by the 2050s.[4]

And as temperatures rise, it could also provide an opportunity to heat our buildings in greener ways. Lundberg says that lower space heating demand should make it feasible to provide much of a passive building's heating need from solar collectors. But he says this presents challenges too: designing a solar system based on a building's heat load could result in an oversized array, which means building designers will need to think about how to store or use excess heat in summer. Climate change should certainly make it possible to downsize heating systems, though.

But increasing temperatures could also mean overheating. The UK climate change assessment projected deaths from overheating to increase by the 2050s, though not as much as the reduction in cold-related deaths.

Andrew Lundberg's research found that Irish passive buildings should cope okay with overheating through extra shading and passive ventilation. But he thinks that even now, overheating is an unrecognised issue for passive buildings in Ireland.

"Overheating is an issue in some passive houses in Ireland and I think it's going to raise its head soon," he says. "Certainly of the passive houses that have been built, some are suffering from overheating. It's something that the industry needs to focus on."

Overheating is deemed to occur if the temperature inside goes above 25C more than 10% of the time, according to the Passive House Planning Package, the software used to design passive houses.

"In reality that threshold may be too high for many people who aren't used to those conditions in their homes," Lundberg says. He adds that the summer bypass function on heat recovery ventilation systems, which brings in fresh air without boosting its temperature, often can't exchange enough air to keep indoor temperatures cool in summer (though many people will address this by simply opening windows).

"In any well designed passive building, controlling overheating is readily achievable through simple measures, however it cannot be ignored at the design stage," he says — essentially the building designer must have a strategy to deal with overheating that will suit occupants now and in the future, whether it's through shading, ventilation or both.

Too much glazing is the big cause of overheating in passive buildings, he says.

"Designers can make the mistake of over-glazing the south façade as a means of achieving target annual heat demand figures, without realising the detrimental effect this may be having on summer comfort levels."

This can lead the client to spend more on glazing, shading and ventilation than they're saving in energy costs from the solar gain through the windows. "Less south-facing glazing might be advantageous," Lundberg says.

West and east facing glazing can also be a big issue, he adds, because the low angle of the sun from the east and west makes it more difficult to control with external shading.

"The simplest way to deal with this may be by not putting in certain windows at all. A careful balance must be struck between the aesthetic, client wishes, daylighting requirements, energy demand and comfort factors. We can't afford to completely sacrifice any one in favour of the other."

But Lundberg expects overheating to be less of a problem in passive buildings anyway. "A well insulated airtight building will generally take longer to respond to changes [in the outside environment] than a poorly insulated building."

How a building responds to changes in outside temperature and solar gain depends not just on U-Values — the rate of heat loss through a material — but on the thermal capacity and density of construction materials.

"Two completely different wall constructions with the same U-values can have significantly different decrement delay values," he says. Decrement delay refers to the time it takes for the peak temperature outside to become peak temperature inside.

Some materials slow down this type of solar gain more than others. For example masonry construction, or choosing insulation such as woodfibre or cellulose over lighter synthetic materials, can offer longer decrement delay.

This isn't generally considered to be of much importance in the UK and Ireland, but that may change as temperatures rise, Lundberg says, and warrants further study.

He also points out that U-values only describe "steady state" heat losses, and that we really need to be analysing a building's performance dynamically using data specific to its location. "This is the direction we are heading in, but we aren't there yet."

Designing passive buildings in hot climates does require some changes in strategy though, such as building in more thermal mass, using less south-facing glass, and adding external shading devices to control solar gain in summer.

But Ireland isn't going to turn into the Sahara just yet, and Lundberg's research has found that during this century, putting blinds on south-facing windows and introducing a proper summer ventilation strategy should be enough to limit overheating in passive buildings without the need for mechanical cooling.

And besides, global warming could also lead to periods of colder weather in winter. The UK Met Office says that greater melting of arctic sea in summer could alter atmospheric circulation patterns, creating high pressure over the arctic and low pressure over mid-latitudes, which tend to bring colder, more easterly winds — particularly in winter. But the Met Office stresses that other factors are at play too, and the role of sea ice in producing cold conditions is still under investigation.

Clearly projecting how our climate will change is a tough task — but regardless, it appears that airtight, super-insulated buildings are generally better protected from the outdoor environment, regardless of whether it's hot or cold out.

And what about rain? Though the projections are uncertain, the UK and Ireland — particularly in autumn and winter, and particularly in their mid and northern regions — are likely to experience more rain. What does this mean for buildings?

"I'm a bit concerned that people are preoccupied with thermal issues, but they're taking their eye off the ball with moisture ingress issues," says John Morehead.

Rainscreens on external walls are one strategy for protecting buildings in areas of high precipitation. And Morehead typically designs buildings with deep roof overhangs, a simple but potentially crucial feature in a wet climate. "The overhangs are very important to protect buildings, particularly because of heavy rain, and particularly in their vulnerable areas," he says.

He says extremely robust detailing is needed for external insulation systems — common on passive buildings and low energy retrofits — in wetter climates. Otherwise wind-driven rain gets into joints, into the building fabric, and can destroy the insulation.

He points out an unexpected issue too — that during floods, insulation that's too buoyant can rise and lift the slab, so less buoyant varieties of insulation are needed for the ground floor in flood prone areas.[*]

He also says that if severe cold snaps were to become more common, it would require building designers to think carefully about choosing very porous building materials in highly insulated buildings — water getting into the fabric would have no opportunity to dry out in cold weather, particularly on shaded sites, and the heavy insulation would prevent the heat inside from warming the external wall.

He also says that passive buildings will have an inherent advantage in extreme wind events. "The airtightness of a passive house will be far more robust in these situations," he says.

The risks climate change poses to buildings and infrastructure are likely to outweigh the benefits, according to the UK's climate change risk assessment. While heat demand and cold-related deaths will decrease, energy demand for cooling will go up, the risk of heat-related illness and death will increase, the urban heat island will get worse, water shortages will become more common in summer, and flood risk will shoot up.

Perhaps the changing climate could convince more householders to meet more of their needs on-site. Rising temperatures are expected to cause electricity transmission losses, and the increased risk of intense cyclones could mean more electricity outages, so the self-sufficient combination of a passive house with on-site electricity generation could start to appeal. Equally, the prospect of water shortages in summer could strengthen the case for rainwater harvesting and storage.

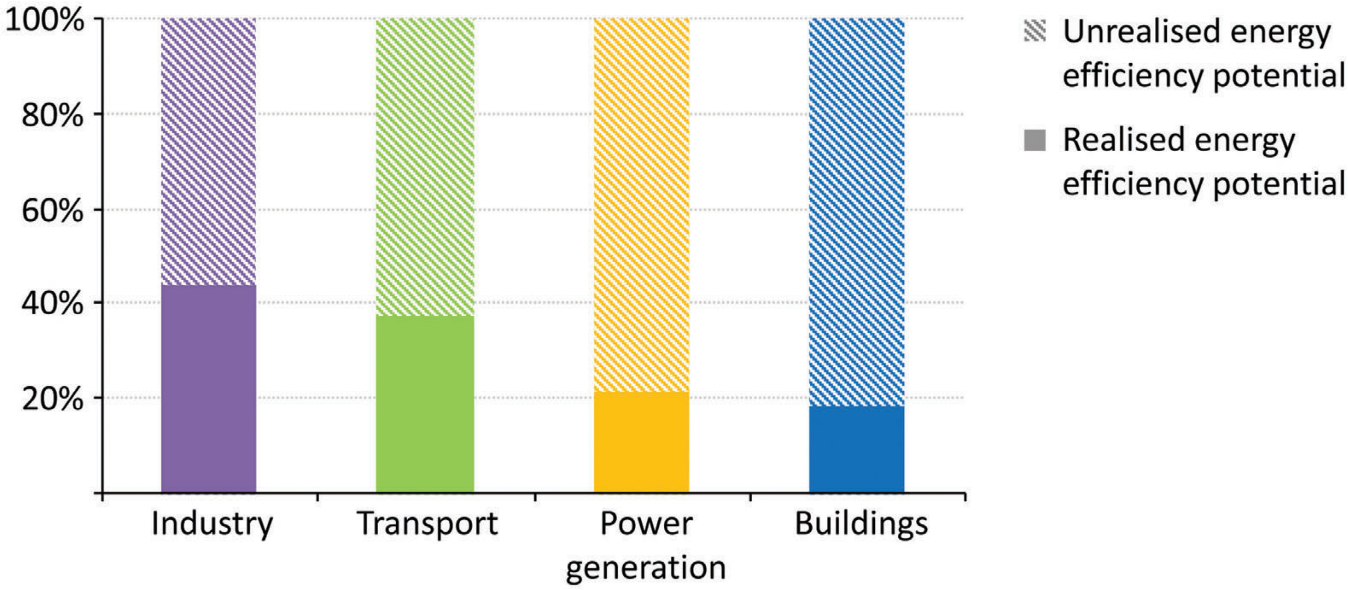
One thing that may need to change is the culture of how we use our homes and offices. Andrew Lundberg reckons there isn't enough of a culture of "building management" in Ireland. We're not used to closing our blinds before we leave for work to prevent overheating, or programming thermostats. Residents must take more responsibility for managing their internal environment, he says.

"My feeling is that the Irish spent so long being used to just turning the heat on," he says. The same could also be said for the UK, where building standards and climate are very similar. "That's generally a cultural issue that we need to deal with," he says.

[*]Engineer Conor Coburn of Construct pointed this out to John Morehead on a recent project of his in which a new slab was being installed in a building in a floodplain

[1]Ireland in a Warmer World, Met Éireann, 2008
[2]Climate: Observations, projections and impacts, United Kingdom. Met Office Hadley Centre, 2011
[3]Parametric analysis of the potential effects of climate change on the performance of a house designed to Passivhaus standards in Ireland, MSc thesis, Andrew Lundberg, University of Ulster, 2009. Available at scanhome.ie
[4]Summary of the Key Findings of the UK Climate Change Risk Assessment 2012

HOW TO RESCUE RETROFIT



Progress on retrofitting Europe's building stock is sluggish, but there is a way out of the mire.

Words: Lenny Antonelli

Is the green new deal dead — or was it ever even born? After western economies tanked in 2008 the idea of green economic stimulus had its heyday.

Making our buildings drastically more energy efficient was at the heart of the plan. We could kill five birds with one stone: cut carbon emissions, make homes warm, slash energy bills, create jobs and kick start sluggish economies.

In the US, then presidential candidate Barack Obama promised to create five million "green jobs". His first stimulus bill as president even backed this up with $90 billion for green projects.

The British prime minister Gordon Brown said the economic crisis was "an opportunity to tackle our over-dependence on oil and to meet our three interlinked objectives – energy security, climate change and job creation – together."

His successor David Cameron took over promising the "greenest government ever." In 2010, the Irish government announced plans to upgrade one million buildings within a decade[1].

But progress has been stagnant. The International Energy Agency says 80% of the "economic potential" of energy efficiency in buildings remains untapped[2].

In Europe we renovate just one per cent of our buildings each year[3]. "This is just not enough, it's not ambitious enough for the future," says Adrian Joyce of Renovate Europe, a retrofit campaign backed by big companies in the energy efficiency sector. "We're just not doing enough renovations, and the renovations we do are not deep enough."

England is now without a government-funded home insulation programme for the first time since 1978. The coalition government has killed Warm Front, which provided insulation and heating grants to low income households. Scotland, Wales and Northern Ireland continue with their equivalent schemes.

One of the programmes that has replaced Warm Front is the Green Deal, which offers retrofit loans that homeowners pay off through their energy bills. The programme's 'golden rule' aims to ensure that savings on energy bills equal or outweigh the loan repayments (though this is not guaranteed).

"The golden rule is rationally a very good idea, but in reality is not going to work," says Adrian Joyce. "If you're only going to consider the rate of payback as the sole criterion, you're almost always only going to have shallow investments."

Even the UK Department of Energy and Climate Change's own assessment expects the number of loft and cavity wall insulations to plummet by 83% and 43% respectively in the first year of the Green Deal and its sister policy, the Energy Company Obligation[4].

Financed by energy companies, the ECO will fund energy efficiency measures in low income households and harder-to-treat properties.

But energy companies will inevitably gather the funding by adding to fuel bills. This will make the scheme regressive, says Andrew Warren of the Association for the Conservation of Energy.

"Poorer people will end up paying a greater proportion of that and will not necessarily be benefiting," Warren says. Essentially, all billpayers will pay the same tariff regardless of income, and while all fuel poor bill payers will help fund the scheme, not all will benefit from energy upgrade measures.

The UK government is obliged to eradicate fuel poverty in England and Wales by 2016, under a law passed in the early days of Tony Blair's government. But this is now virtually impossible: research suggests there are nearly eight million people in fuel poverty in England, and this is expected to rise[5] as the government cuts funding to tackle it[6].

In Ireland, retrofit is in limbo. The current government came to power in 2011 promising to

double funding for home energy efficiency and renewable energy until 2013, and to insulate all public buildings in the state via pay-as-you-save.

Neither commitment has materialised. The government has cut its Better Energy heating and insulation grants twice since 2011. It slashed the programme's budget from €76m in 2012 to €50m in 2013[7], but has promised a new €35m "energy efficiency fund".

The number of Better Energy measures approved — a good indicator of the number of applications— fell from over 160,000 in 2011 to less than 65,000 in the first 11 months of 2012[8].

The Better Energy Warmer Homes scheme, which funds energy efficiency upgrades to the homes of the elderly and vulnerable, upgraded over 37,000 houses in 2010 but only around 14,000 last year (including about 2,000 in a new area-based pilot that aimed to tackle clusters of houses)[9].

Energy minister Pat Rabbitte recently told the Irish Times that while 5,500 people were employed due to government retrofit programmes in 2011, the figure for 2012 could be up to 1,000 less.[10]

Ireland's goal is to upgrade one million buildings by 2020, almost all of which will be dwellings. But the rate of activity needs to pick up because the country is currently upgrading 50,000 to 60,000 homes a year, according to the National Economic and Social Council[11]. The vast majority of upgrade measures are shallow ones too, focusing heavily on low cost measures like cavity wall and loft insulation. NESC says there is an "urgent need to bring forward new measures" to meet the targets.

So how do we turn things around? Two recent reports illuminate the way forward. Oxford University's fuel poverty expert Brenda Boardman's Achieving Zero offers a devastatingly simple set of policies that, she says, could make all buildings in the UK zero carbon by 2050[12].

Here are just a few of them: Introduce energy standards for existing buildings, and then raise them over time. Require all homes and businesses to have an energy rating. Get building control officers to act as low energy "mentors" on construction projects. Develop low carbon zones in each local authority to tackle clusters of fuel poor households. Phase out grants and replace them with subsidies to make energy efficiency loans more affordable. Reduce taxes on energy efficient goods, and on energy efficient properties. Introduce scrappage schemes for old appliances.

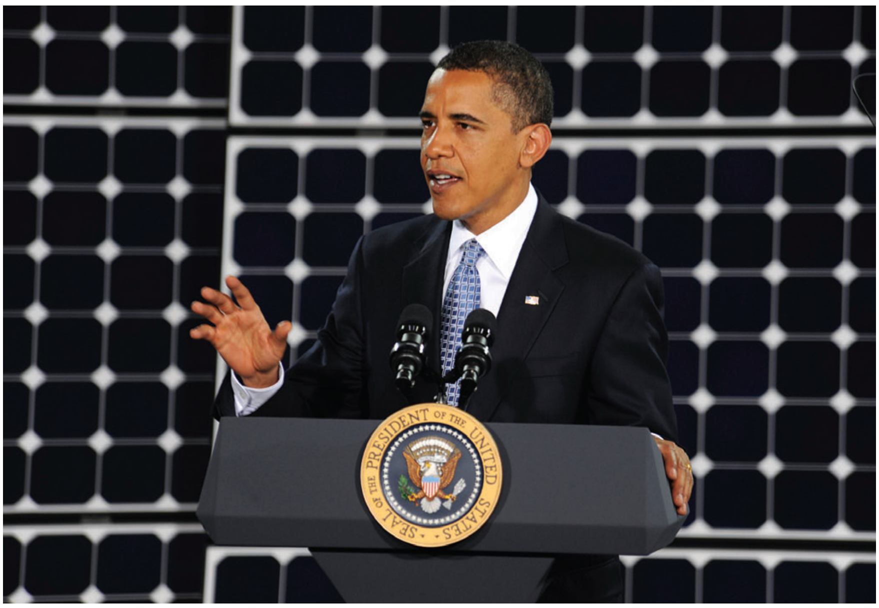
Boardman also says it's essential to her plan that energy efficient properties become worth more than energy inefficient ones.

Ireland has already taken a step towards this by making it mandatory to display a property's energy rating anywhere it is advertised for sale or rent in an admirably strict interpretation of a requirement in an EU directive.*

Meanwhile, research by the consultancy Copenhagen Economics, commissioned by Renovate Europe, identifies ways to smash some of the main barriers holding back retrofit[13].

First, allow landlords and tenants to split the gains from energy efficiency projects — right now, the 'split incentive' means that landlords must pay to upgrade rented properties but don't ▸

Political posturing or meaningful action? David Cameron on a climate "research" trip to Norway when in opposition; (below, second & third from left) Irish enterprise minister Richard Bruton & energy minister Pat Rabbitte spin a green jobs message at the International Energy Research Centre launch while retrofit jobs are falling; (bottom) US President Barack Obama announcing a renewable energy programme in 2009 (p72, top) Association for the Conservation of Energy director Andrew Warren, (bottom) Passive House Institute director Prof. Wolfgang Feist



Photos from top: Alpha Photo Press Agency / ImageCollect; Jason Clarke Photography; Brian Ybarbo, USAF

Photos from top: EC/CE; Mirko Bartels

enjoy any of the benefits, so they have little incentive to invest. (Ed. – The new requirement to advertise energy ratings should help make energy efficiency a key factor in the rental market, by exposing would-be renters to each property's energy rating before they've formed an opinion about the property – before they've even read the property listing, never mind set foot across the threshold.)

Second, reform public accounting rules so state bodies can get financing for retrofit. At present many public bodies must put the full cost of an upgrade on one year's budget — at a time when public budgets are under severe pressure. They are often forbidden from counting post-upgrade energy cost savings in their budgets too.

Third, reduce or remove tax breaks and subsidies on fossil fuels, which discourage investment in energy efficiency.

And finally, develop smart risk-sharing programmes like energy performance contracting. Banks have little experience calculating the risk involved with energy efficient investments, so may be reluctant to lend. Retrofit projects often demand big up-front investment, which implies big risk. Energy performance contracting, under which a utility aims to ensure that energy cost savings pay for the retrofit, helps to manage that risk.

But a bigger culture change is needed too. Despite economic meltdown, governments are still reluctant to intervene too heavily in their economies, and are wedded to austerity over growth and investment.

Last October, the United Nations said that breaking the "vicious cycle" of rising unemployment, austerity, fragile banks and deleveraging demanded "shifts away from fiscal austerity…towards job creation and green growth"[14].

But what might this shift look like? Last year, Passive House Institute director Wolfgang Feist proposed an "energy revolution" for Europe. With €400bn of investment Europe could trigger €3 trillion of private funding and cut the energy use of all its post-war buildings by 85%. This would create 2.2 million jobs, save 530 million tonnes of CO_2 and trigger four trillion euro in energy cost savings, according to the institute. But Feist said it's crucial that such a programme only support deep retrofit projects, otherwise it will just cement poor energy efficiency into the system[15].[**]

Retrofitting fuel poor homes also creates more economic growth than cutting VAT or fuel duty, and creates more jobs than spending on other capital projects, according to research by Cambridge Econometrics and the climate change consultancy Verco[16].

Of course, you might expect groups like the Passive House Institute and Renovate Europe to push for a massive energy efficiency drive. But the International Energy Agency, hardly a bastion of green thinking, offers a similar vision in its latest World Energy Outlook.

The report models what would happen in an 'efficient world' scenario, in which all "economically viable" energy efficiency measures — policies that pay for themselves within a reasonable timeframe — are implemented for buildings, transport, power and industry between now and 2035, and all market barriers to their introduction are removed[17].

None of these policies would be particularly onerous or expensive to implement — they just demand political will.

In this scenario, governments bring in tough energy standards for new buildings — and those undergoing renovation — and keep pushing them upwards. Minimum energy standards and labelling schemes apply to all energy-using equipment. There are more, and deeper, retrofits as governments remove barriers to action. Old industrial equipment is retired early and replaced by the most efficient technology. Tough fuel economy rules, energy labelling and incentive drives demand for the most efficient road vehicles. New efficiency rules for power stations come into force, and more support is given to combined heat and power and technology. Smart electricity grids become the norm.

All of these ideas pay for themselves within strict time periods. For buildings, this means 14 years for heating measures, and three years for electrical ones.

The IEA modelled the economic consequences of making their 'efficient world' scenario a reality. It admitted this is an exercise filled with uncertainty, but is confident the benefits far outweigh the costs.

Here's what the IEA says happens in their 'efficient world': Demand for oil peaks by 2020, then declines. Demand for coal falls too, while demand for cleaner natural gas rises. Energy-related CO_2 emissions peak by 2020 and then falls. Universal access to modern energy becomes easier to achieve, and local air quality improves, particularly in India and China. Demand for energy grows much more slowly. The world's cumulative economic output increases $18 trillion dollars up to 2035.

But Adrian Joyce of Renovate Europe says policymakers need to look even further, to the less quantifiable benefits of living in warm, comfortable, properly ventilated homes, to factors such as indoor air quality, productivity, and even happiness.

"These things count in people's lives, but it's hard to put them on a sheet of paper. They're not taken into account in what are cost optimal measures, and in our view they ought to be," he says.

The Copenhagen Economics study found that savings from lower healthcare costs and greater worker productivity can account for around half the economic benefits to society of retrofit, though it admitted such calculations are fraught with uncertainty[18].

But this points to a new way of thinking about the advantages of energy efficient buildings that looks at more than just fuel bills. Adrian Joyce says he's constantly touting the need to consider indirect benefits like health when evaluating the benefits of retrofit. "It piques the interest of people, but I wouldn't say it's getting traction yet," he says.

"But I'm beginning to feel we're softening the resistance."

[*]Ireland's actions are simply a strict interpretation of Article 12 of the Recast Energy Performance of Buildings Directive, which states that the energy performance of a building must be included in "advertisements in commercial media." Every EU member state was obliged to enact this requirement in law by 9 January, with no derogations possible

[**]Passive retrofit projects may also be less likely to cause a rebound effect, the phenomenon whereby energy upgrades encourage occupants to use more energy by lowering their bills. It is usually too expensive for building occupants to adequately heat all of a highly energy inefficient building. Once that building is upgraded to be moderately efficient, it suddenly becomes easier and more affordable to heat all of it. But if a deep or passive retrofit is undertaken, there is likely to be much less of this "comfort taking" as heating the building any further will not make it more comfortable. Research by the Passive House Institute suggests that for retrofit, the actual energy consumed is very close to that projected. See the series of articles on retrofit & refurbishment at http://passipedia.passiv.de)

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[4]Final Stage Impact Assessment for the Green Deal and Energy Company Obligation, Department of Energy & Climate Change (UK), p148 & p166
[5]Getting the Measure of Fuel Poverty, John Hills, Centre for Analysis of Social Exclusion, 2012
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[7]Correspondence with Department of Communications, Energy & Natural Resources
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[9]Correspondence with SEAI
[10]Rabbitte insists he is a good fit for his department and is excited about future, Irish Times, 4 January 2013
[11]Towards a New National Climate Policy: Interim Report of the NESC Secretariat, National Economic and Social Council, June 2012m p86 & 87
[12]Achieving Zero: Delivering Future Friendly Buildings, Brenda Boardman, Environmental Change Institute, University of Oxford, 2012
[13]Multiple Benefits of Investing in Energy Efficient Renovation of Buildings: A Study by Copenhagen Economics, Renovate Europe, 2012
[14]World Economic Situation and Prospects 2012, Update as of mid-2012, United Nations
[15]Master plan for the European Energy Revolution, presented at 2012 International Passive House Conference. www.passiv.de
[16]Jobs, Growth and Warmer Homes: Evaluating the Economic Stimulus of Investing In Energy Efficiency Measures in Fuel Poor Homes. Final Report for Consumer Focus. Cambridge Econometrics & Verco, October 2012
[17]World Energy Outlook 2012, International Energy Agency, p35
[18]Multiple Benefits of Investing in Energy Efficient Renovation of Buildings: A Study by Copenhagen Economics, Renovate Europe, 2012

glossary

*Perplexed by all this talk of U-values, blower door tests and embodied energy? This glossary will help you get to grips with the key terminology. These entries will be added to an online glossary at **www.passivehouseplus.ie/glossary**, which will continue to grow in detail as each new issue comes out.*

airtightness The degree of air leakage or air infiltration a building has. Making a building airtight essentially means eliminating draughts within buildings, and should not be confused with windtightness. Both address the sealing of a building – the internal envelope in the case of airtightness, and the external envelope in the case of windtightness.

Airtightness is typically measured in two units: air changes per hour (ACH) or n50 and air permeability ($m^3/hr/m^2$) or q50.

blower-door test This is used to work out a building's airtightness. A fan mounted to an external door is used to pressurise or depressurise the interior of the building, forcing air in or out through any gaps or cracks. The building's airtightness is determined by measuring the force needed to maintain a certain pressure difference (typically 50 pascals) between the inside and outside of the house.

BREEAM This is the Building Research Establishment (BRE) Environmental Assessment Method, a system to assess the environmental impact of non-domestic buildings against criteria including energy consumption, water, materials, waste, transport, ecology, pollution and health. It has five levels: pass, good, very good, excellent and outstanding. And fail of course.

Building Energy Rating (BER) The Irish government's rating system used to measure the energy efficiency of buildings. BERs range from a 'G' for poor efficiency to an 'A1' for best efficiency, and are expressed in kilowatt hours of primary energy use per square metre per annum ($kWh/m^2/yr$).

Building Emissions Rating (BER) The British government's system for rating the carbon emissions of a building's energy use for heating, hot water, cooling and lighting. For regulatory compliance purposes in the UK the BER score – measured in kg $C0_2/m^2/yr$ – must be below the maximum permitted Target Emissions Rating (TER).

The Code for Sustainable Homes The BRE's environmental assessment tool for dwellings. As with BREEAM, buildings are assessed on their overall environmental performance, resulting in six levels of scoring.

coefficient of performance (COP) This measures the energy efficiency of certain heating and cooling appliances, such as heat pumps. COP is the ratio of useful energy output (heating or cooling) to the amount of energy put in, so a heat pump with a COP of 4 to 1 puts out four times as much energy as it uses. The higher the COP, the more efficient the device. See also the seasonal performance factor (SPF).

cold bridging See 'thermal bridging'

Dwelling Energy Assement Procedure (Deap) A software programme used to calculate the Building Energy Rating (BERs) of buildings, and to demonstrate compliance with energy efficiency targets for new homes under part L of the building regulations.

embodied energy Energy required to extract, manufacture process, transport, and install a product.

greywater Wastewater from baths, sinks, dishwashers, washing machines etc - essentially all a house's wastewater except that from toilets and macerators/food grinders.

heat recovery ventilation (HRV) A technology that ventilates a building while also recovering heat from extracted air. HRV systems typically extract warm, damp air from 'wet' rooms like kitchens and bathrooms and use it to heat cool, fresh incoming air, which is then usually piped to living spaces such as living rooms and bedrooms. Also referred to as mechanical ventilation with heat recovery (MVHR).

life cycle assessment An examination of a material or product's impact (typically on the environment, but also on people/society) throughout its life cycle, from the extraction of raw materials through to its disposal or recycling.

n50 – See airtightness

passive house / passivhaus Passive house is a rigorous ultra-low energy building standard. Developed in Germany in the early 1990s, the standard has led to the design of buildings that are so energy efficient they don't require conventional heating systems.

Designed to be extraordinarily good at retaining heat, passive houses make the most of free heat wherever possible – whether in the form of passive solar gains through windows, metabolic gains from occupants, or recovering most of the heat that would otherwise be lost venting hot, wet air from cooking or washing.

To be certified by the Passive House Institute, buildings must meet three strict criteria:
1) A space heating demand of no more than 15 $kWh/m^2/yr$, as calculated using PHPP. An alternative here is if the specific heat loads is 10 w/K or less, though this appears to be at the discretion of the certifier.
2) A primary energy demand of no more than120 $kWh/m^2/yr$ for ALL domestic energy use – unlike BERs (Ireland) or EPCs (UK) which don't deal with energy use from electrical appliances.
3) An airtightness of no more than 0.6 ACH at 50 Pascals.

The term passive house is often used to describe buildings that, while not being officially certified by the institute, still appear to be close to the standard. There's a distinction to draw here between buildings which have been run through PHPP, hit all the main targets and look like they could be certified – the institute itself includes some such buildings in its database at passivhausprojekte.de – and misuse of the term, including buildings which have been designed using other software but use the sorts of specifications that abound in certified passive houses, and people who misguidedly use passive house as a generic term for any vaguely energy efficient measures.

Many people in the UK use the original German term "Passivhaus" to distinguish buildings which meet the criteria from those which either have been found to fall short – or weren't even assessed in the first place. Our preference is for passive house, partly because we don't want the term to be abused, English spelling or not.

Passive House Planning Package (PHPP) A software programme developed by the Passive House Institute that's used to design and test buildings aiming to meet the passive house standard.

Primary energy This is energy use at source prior to conversion into useful forms, which is referred to as delivered energy or final energy. The gap between primary and delivered energy varies enormously for different energy types. In the case of electricity, PHPP assumes a primary energy factor of 2.6 – meaning every kilowatt used at the plug socket requires 2.6 kilowatts to be generated at the power station.

q50 – See airtightness

seasonal performance factor (SPF) The ratio of useful heat energy output from a heat pump to the electrical energy input (including compressor, circulation pumps and electrical immersion, if present) averaged over an entire heating season. See also COP

thermal bridging A thermal bridge occurs when heat or cold transfers across an external surface of a building. See longer definition online.

U-value The U-value of a material is the rate of heat loss through that material. The lower the U-value of a material, the less heat can pass through it and the better it is at insulating. U-values are measured in watts per metre squared kelvin (W/m^2K).

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